SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL 1912.

GENERAL PHYSICS.

422. *Properties of a Split Tube submitted to Torsion.* **T. Millet.** (Bull. Soc. d'Encouragement, 117. pp. 21–24, Jan., 1912.)—A particular case is dealt with, but the conditions admit of considerable variation. A brass tube, about 2 cm. in diam., was slit down a line parallel to the axis, the slit being about 1·5 mm. wide. The tube was provided with five collars, which were soldered to the tube, and the slit also passed through these. The collars were equidistant, two being at the ends of the tube. Such a tube, fixed at one point of its length, will transmit an alternating circular motion of the opposite sense to that of the original motion, the amplitude being increased or diminished in the same ratio as that of the lengths of tube on either side of the point of fixture. Again, if a cylinder, carrying a projection P passing through the slit, is inserted in the tube, the projection P will have a helicoidal motion as the cylinder is moved in and out of the tube, the motion being right-handed or left-handed according to the torsion of the tube. If the tube has a block at each end, the blocks being kept always in contact with the ends of the tube, an alternating circular motion of one end of the tube, of which one point is fixed, will generate an alternating linear motion of the blocks of small amplitude. A. W.

423. *New Method of measuring Stress.* **G. Wazau.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 268–270, Feb. 17, 1912.)—The method described is a modification of the "control" or "standard bar" method in which a carefully shaped specimen is stressed in the testing machine and the existing stress deduced (from a previous direct calibration) by exact measurement of the elongation. The standard bar used by the author is much shorter than usual, and thus takes up less space in the machine. The elongation is measured hydraulically, the displaced volume being measured by a piston which is moved by a micrometer screw. The author claims robustness, simplicity, and compactness for his device. It may be handled by the unskilled, and does not alter with time. H. S. R.

424. *Dynamic Tensile Tests.* **R. Plank.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 17–24, Jan. 6, and pp. 46–51, Jan. 13, 1912.)—Tests were made on wrought-iron bars in a drop-testing machine which recorded automatically a curve of extensions against time on a revolving drum. The distinction between a static and a dynamic test is that in the first the load rises gradually to a maximum, whilst in the second it rises suddenly after the impact and then diminishes. The problem of the stresses set up and the effect of the speed, force, and number of the blows on them is investigated theoretically. If $x =$ extension of bar at time t, $m =$ mass of weight falling distance h, $a^2 = \mathrm{E}f/l_0$, where $\mathrm{E} =$ modulus of material, $f =$ cross-section area, $l_0 =$ initial length; then $d^2x/dt^2 + a^2x/m = g$. This equation, on being integrated, and having constants evaluated reduces to $x = gm/a^2 + \sqrt{(gm/a^2)^2 + gm/a^2 . 2h}$ $\sin\ (at/\sqrt{m})$. Thus the $x - t$ curve is a sine wave, and, neglecting the small static elongation gm/a^2, $x_{\text{max.}} = \sqrt{2gmh/a^2} = \sqrt{2\mathrm{G}hl_0/\mathrm{E}f}$. By differentiating the curve of x the curve for dx/dt, the rate of straining, is obtained. A further curve for $m . d^2x/dt^2$ gives the resisting force P. The tests showed that the weight could be dropped any height up to 8 cm. at will without causing permanent set, though stresses of 4000 kg./cm.^{2} were set up, which in a static test would cause fracture. The ideal case above is not found in practice, the vibrations being rapidly damped by air and internal molecular frictions. The max. stress actually occurs before the greatest strain, and the curve is not a true sine function for this reason. Newton stated for fluids that molecular friction is proportional to the speed of slipping of neighbouring surfaces. On this assumption the equation becomes $d^2x/dt^2 + \mu/m . dx/dt + a^2/m . x = 0$, where the weight of the falling piece is neglected in comparison with the elastic force P. μ is the damping factor in a damped vibration if $\mu < 2a\sqrt{m}$. This equation gives $x = (v_0/\mathrm{K}_1)e^{-\mu t/2m} \sin \mathrm{K}_1 t$, where $\mathrm{K}_1 = \sqrt{a^2/m - \mu^2/4m^2}$, and v_0 is the velocity when $x = 0$. Thus a vibration is obtained whose amplitude decreases exponentially, but which remains isochronous. It follows that—

$$v = dx/dt = v_0/\mathrm{K}_1 . e^{-\mu t/2m}\,(\mathrm{K}_1 \cos \mathrm{K}_1 t - \mu/2m . \sin \mathrm{K}_1 t).$$

Since the bar is not fixed to the specimen it leaves the latter after a half-swing, being free to move vertically with their joint velocity and acceleration. Thence the diagram obtained only gives a half-swing of the above curve, but μ can be determined if the times of max. displacement and the next zero are located. $x = 0$ for $t = 0$, π/K_1, $2\pi/\mathrm{K}_1$, &c., and $x =$ max. for $t = 1/\mathrm{K}_1 \tan^{-1} 2\mathrm{K}_1 m/\mu$, $\pi/\mathrm{K}_1 + (1/\mathrm{K}_1)\tan^{-1}(2\mathrm{K}_1 m/\mu)$, &c. If $\mathrm{AB} = \pi/\mathrm{K}_1$, $\mathrm{AC} = (1/\mathrm{K}_1)\tan^{-1}(2\mathrm{K}_1 m/\mu)$, then let $(\mathrm{AB} - 4c)/\mathrm{AB} = \phi$. By substitution: $\mu = 2a\sqrt{m} \cos\ [\pi\phi/(1 + \phi)]$. AC and AB are measured from the autographic diagrams, hence μ is calculated. The actual displacement-time curve agrees very well with the theoretical curve, for strains within the elastic range $\mu = 7$. The work indicated by the dynamic stress-strain diagram agreed within 2 per cent. with that calculated from the net work done by the bar on the specimen. The results of repeated impact tests tend to confirm former work on the subject. The permanent sets which occur after the same number of blows from various heights h, are directly proportional to $h - h_0$, where h_0 is that height for which strains are still just purely elastic.

C. A. M. S.

425. *Dependence of Breaking Strength upon Temperature.* **F. Hauser.** (Deutsch. Phys. Gesell., Verh. 14. 1. pp. 18–32, Jan. 15, 1912.)—This is a continuation of previous tests [see Abstract No. 260 (1912)] on rubber, wax, and rosin. The breaking strength of pure clear rosin rises to a sharp maximum at about 30° C. The influence of added turpentine-oil is similar to that of wax. The max. strength and the temperature at which it is attained fall with rising turpentine-content, at 10 per cent. turpentine the strength falls away without rising beyond the value at 0° C. Tests at temperatures above 0° C. are impossible with more than 10 per cent. turpentine. The reliability of fractures of clear rosin with talc added cannot be judged from the appearance, as the whole section has a rough sandy texture. Specimens were, therefore, rejected which showed blow-holes or other irregularities. The effect of talc is not to change the max. strength appreciably, but the temperature of attainment rises. The strength at low temperatures is raised, probably owing to the diminished brittleness. The decrease of strength after passing the maximum is slower when talc is added, so that the curve becomes flatter. Shellac has properties similar to those of hard rubber. Turpentine-oil or resin-gum diminishes the strength of shellac, yet the effect is much less than on clean resin. By mixing shellac and clear rosin in varying proportions curves of strength against temperature are obtained, which merge from those of one material pure into those of the other pure. The similarity is very great between the temperature curves for shellac-rosin and rosin-talc, and those of Bach for wrought-iron. C. A. M. S.

426. *Torsion of Rods of Rectangular Cross-section, and Extension and Contraction in Area of Rods under Tension.* **O. Bretschneider.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 258–259, Feb. 17, 1912.)—The usual formula for the angle of twist θ per unit of length, of a rectangular shaft is—

$$\theta = 3{\cdot}6\mathrm{M}_d\beta(b^2 + h^2)/b^3h^3,$$

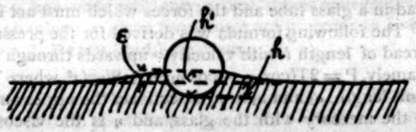
where M_d is the applied torque, β the reciprocal of the modulus of rigidity, and b and h are the sides of the rectangle. The stress $\tau_{\max.} = 4{\cdot}5\mathrm{M}_d/b^2h$. These formulæ were evolved to replace the more complex theory of St. Venant, and give results which vary from those of the latter from 20 per cent. to 50 per cent. The present tests were made to investigate the true stresses and angular deflections and the reliability of the above formulæ. The tests show that the relation holds: $\theta = \psi'\mathrm{M}_d\beta(b^2 + h^2)/b^3h^3$, where ψ' is a coefficient depending on the ratio h/b, and made constant, and $= 3{\cdot}6$ in the ordinary formula. Actually, ψ' is found to vary with h/b, and the experimental values differ from those given by St. Venant by not more than 1·5 per cent. For shafts with h/b between 1 : 1 and 6 : 1, ψ' may be represented by $\psi' = 3{\cdot}645 - 0{\cdot}06\, h/b$ for wrought-iron within the limits of proportionality. The distribution of stress over the section as determined by St. Venant is compared with that indicated by the usual formula. The discrepancy between the two increases rapidly with increase of h/b. These tests do not enable the stress distribution within the elastic limit to be determined. The tension results depend on the value of β, which is usually determined from the expression $\beta = 2\alpha(m + 1)/m$, where α is the reciprocal of the stretch modulus, and m the ratio of axial to lateral strain of a piece of material in pure tension. The authors used a special apparatus to determine m from the direct measurement of the axial and lateral strains. Within the limit of proportionality m was sensibly constant for wrought-iron, being $= 3{\cdot}34$ for annealed, and 3·65 for hard unannealed metal. The relation: $\beta = 2\alpha(m + 1)/m$ is confirmed for the wrought-iron used within the elastic limit. Further tests were made on two high-grade cast-irons. The results were very variable, but it could be seen that m grew with the applied stress from 3 at 60 kg./cm.^{2} to about 6 at 1300 kg./cm.^{2}. C. A. M. S.

427. *Collapse of Thick Cylinders under High Hydrostatic Pressure.* **P. W. Bridgman.** (Phys. Rev. 84. pp. 1–24, Jan., 1912.)—In ordinary experiments the range of stress attainable is limited by the fact that rupture occurs; in the author's method rupture never occurs, no matter how high the stress. Plugged steel and copper cylinders $\frac{9}{16}$ in. outside diam., and with bores varying from $\frac{1}{16}$ in. to $\frac{9}{32}$ in., are subjected to external hydrostatic pressure up to 12,000 atmos. After increments of 1000 atmos. the cylinders are removed and accurately measured internally and externally. When the walls are thin the collapse is unsymmetrical, due to instability of form, but this asymmetry may decrease due to the thickening of the walls by inward flow. A second series of experiments is described, in which steel plugs project into the pressure chamber. The plugs have outside diams. of about $\frac{9}{16}$ in., and bores varying from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. The bore is connected to a capillary tube filled with mercury, by which changes of volume of bore may be measured. The mathematical theory of the problem is discussed. All three principal stresses at a point are compressive except the radial stress, which may be zero at the inner surface, where the greatest principal stress-difference occurs. The yield under any given pressure does not continue indefinitely, but stops after a while. With the next application of pressure, yield is not resumed until the old maximum is reached. The cylinder cannot support an indefinite pressure, but closes up tight at some fixed pressure, the same no matter what the original dimensions of the cylinder. For copper this is about 10,000 atmos. For soft steel, judging from an extrapolation, it must be at about 20,000 atmos. The fact that the cylinder closes up shows that the max. stress-difference criterion for flow is not valid. The max. stress-difference that the material can support, decreases after prolonged flow. In the cases considered by the author flow can only take place in the plane of greatest and least principal stress. The internal adjustment or whatever enables the metal to stand these great pressures, does not result in a general raising of the resistance to all kinds of stress, but it is an accommodation only to the particular type of stress which produced the yield. A cylinder collapsed by external pressure bursts under less than the normal pressure. The time rate of plastic yield changes as the pressure increases. At low pressures the greater part of the yield occurs in the initial stages, but at higher pressures the yield is more evenly distributed in time. A slower rate of yield is found in larger masses of metal, even although the total yield may not be so great, and the rate is slower in tool steel than in Bessemer steel. The tool steel has a more complicated internal structure. The usual hardening effect of overstrain is shown; an interval of rest after the overstrain being necessary for the hardening. This interval is greater for larger masses of metal and is greater for tool steel than Bessemer steel. Elastic after-effects do not seem to increase markedly with increasing pressure. Hysteresis is shown by all the cylinders. It is greater at higher pressures, and is much greater than under ordinary conditions of test. The breadth of a hysteresis loop may be as great as the entire elastic deflection before yield began. Hysteresis is very much greater in tool than in Bessemer steel, and shows a tendency to be larger in larger masses of metal. During the accommodation period a thick tool-steel cylinder shows an anomalous increase of bore-volume, due to increase of external pressure. The breaking-up of unstable molecular complexes, and the formation of new complexes, stable under the new conditions, may, the author thinks, be connected with many of his results. For this process takes a longer time in large masses of metal, and produces greater changes in a material of complex structure. H. S. R.

428. *Investigation of Stresses in a Rectangular Bar by means of Polarised Light.* **L. N. G. Filon.** (Phil. Mag. 23. pp. 1–25, Jan., 1912.)—The experiments described were undertaken some years ago with a view to verifying the results of de Saint-Venant relating to the parabolic distribution of shear in a long bar of rectangular cross-section at a distance from the point of loading. The method used depends upon the well-known property of glass, that under mechanical stress it becomes doubly refracting and a plane wave of light traversing it is broken up into two plane-polarised components. Maxwell pointed out that two types of bands could be obtained: isochromatic lines and lines of equal inclination (the latter called isoclinic lines in this paper). As the nicols used are rotated the isoclinic lines vary, but the isochromatic lines remain fixed. The investigation made confirms the results obtained by the mathematical theory of elasticity. It confirms the parabolic distribution of shear across a bar of rectangular section, which is usually assumed by engineers, provided it is applied to points at a reasonable distance for points of loading. In the neighbourhood of points of loading the theory worked out by the author is confirmed by his experiments. The author advocates the use of isoclinic lines in place of isochromatic lines for "photo-elastic" problems.

C. A. M. S.

429. *Hardness and Brittleness of Steels.* **Grard.** (Rev. de Métallurgie, 8. pp. 241–248, 1911. Metallurgie, 8. pp. 715–717, Nov. 22, 1911.)—In the Brinell ball hardness-test the metal is pressed out all round the ball as shown in the Fig., and the calculated value of the hardness varies considerably according as the depth of the depression is taken as h or $h' = h + \epsilon$, *e.g.*, when the area of the surface of the depression is calculated from h' instead of h the hardness figure of mild steel is found to be lowered by 24. The value calculated from the mean diam. of the depression agrees with the value calculated from h'. Rapidity of loading affects the area of the depression considerably, so that a time of 2 minutes for ordinary work and 5 minutes for very accurate work has been fixed for attaining the load of 3000 kg. In rolled materials the depressions made at right angles to the direction of rolling are greater than those made in the direction of rolling, showing that the hardness is greater in the latter directions. The max. experimental error allowable in tests carried out under similar conditions is ± 5 units, greater differences being attributable to structural differences in the material. Therefore the method is an accurate guide to homogeneity. Between the tenacity R and the hardness Δ there exists a relationship which is summed up by the equation $R = \Delta K$, where K is a coefficient depending upon the nature of the steel and varies from 0·360 for extra soft steel to 0·318 for hardened steel tempered at 500° to 650° C. The relation between hardness and brittleness of ordinary carbon and special steels is also discussed. A combination of great hardness and high resilience is a characteristic of the special steels which have been suitably heat-treated.



F. C. A. H. L.

430. *Adherence of Flat Surfaces.* **H. M. Budgett.** (Roy. Soc., Proc. Ser. A. 86. pp. 25–35, Dec. 22, 1911.)—In recent years it has been found possible to polish plane surfaces of hardened steel to a degree of accuracy which had previously been approached only in the finest optical work, and to produce steel blocks in the form of end gauges which can be made to adhere or "wring" together in combinations. These blocks will often cling together with such tenacity that a far greater force must be employed to separate them than would be required if the adhesion were solely due to atmospheric pressure. In the present paper the various causes which produce this adhesion are examined; also an attempt is made to account for the force which can be resisted by such a film. Experiments on specially-made steel blocks showed (i) that at least 75 per cent. of the adhesion is caused by the presence of a liquid film between the surfaces in contact; (ii) that not more than 25 per cent. is due to atmospheric pressure; (iii) that the adhesion practically vanishes when no film is present; (iv) that the attraction of the molecules of steel in one face by molecules of steel in the opposite face is negligible. From an examination of various liquid films it is concluded that (1) breakage occurs in the liquid itself, and not between the liquid and the steel; (2) only 4 per cent. of the force required to rupture the film is due to surface tension; (3) the remaining 96 per cent. must be necessary to overcome the molecular cohesion of the liquid. The tensile strength of water may, under special conditions, amount to nearly 60 atmos. The figures obtained for the breaking strain of liquids are far higher than those previously obtained by other methods, owing probably to the fact that no air-bubbles of any magnitude can possibly be present in the films, and the action of wringing the blocks together must bring the liquid into very intimate contact with the steel. It does not appear likely that results of this magnitude (800 to 900 lbs. per sq. in.) could ever be obtained with larger volumes of the liquids, for if the thickness of the film is increased the pull required to cause separation rapidly diminishes. A. W.

431. *Resistance to Motion of a Thread of Mercury in a Glass Tube.* **G. D. West.** (Roy. Soc., Proc. Ser. A. 86. pp. 20–25, Dec. 22, 1911.)—The object of the research was to investigate the connection between the motion of a mercury thread in a glass tube and the forces which must act in it to produce that motion. The following formula was derived for the pressure P necessary to drive a thread of length l with velocity v upwards through a vertical tube of radius a, namely, $P = 2T(\cos\alpha_2 - \cos\alpha_1)/a + 8l\eta v/a^2$, where T is the surface tension per unit length, α_1 and α_2 are respectively the upper and lower angles of contact of the mercury with the glass, and η is the viscosity coefficient. The formula was first tested experimentally on tubes about 8 mm. in diam., for which the viscosity term is negligible. Within the errors of experiment the driving pressure was found to be independent of the length of the drop and also of the velocity. Hence α_1 and α_2 are not dependent on the velocity, *i.e.*, a moving drop of mercury has a front and a rear angle of contact which are independent of the velocity with which the drop is moving. To test the last term tubes of diam. 0·35 mm. were used, and the results agree closely with the theoretical values. From the experiments the following formula is finally deduced; $P = 0{\cdot}038/a + 8l\eta v/a^2$. A. W.

432. *Resistance to Motion of Small Spheres.* **M. Knudsen and S. Weber.** (Ann. d. Physik, 36. 5. pp. 981–994, Dec. 21, 1911.)—A thin horizontal rod of Pt was made to vibrate in air in a kind of torsion balance, and the damping was measured. Then glass balls were attached to the ends and the damping redetermined. The results were used to correct Cunningham's formula [Abstracts Nos. 788 (1910), 899 (1911)]. The new formula for the resistance K is: $K = 6\pi\eta Rv(1 + 0{\cdot}68\lambda/R + 0{\cdot}35\lambda/R\,e^{-1{\cdot}85R/\lambda})^{-1}$, where η is the viscosity, v the velocity, and λ a quantity approximately equal to the mean free path, but is really defined by the relation $p\lambda = (\sqrt{\pi}/8/0{\cdot}30967)\,(\eta/\sqrt{\rho_1})$, where p is the pressure of the gas and ρ_1 its density at a pressure of 1 degree/cm.². All the quantities are measured in absolute c.g.s. units. McKeehan's recent formula $K = 6\pi\eta Rv(1 + A\lambda/R)^{-1}$, where $A = 1$, agrees with the results when R/λ is small, but there is a great discrepancy when it is large. E. E. F.

433. *Brownian Motions in Gases at Low Pressures.* **de Broglie.** (Comptes Rendus, 154. pp. 112–113, Jan. 15, 1912.)—According to the formula of A. Einstein, $\Delta^{2} = \frac{RT}{N}\cdot\frac{\tau}{3\pi wa}$, the mean Brownian displacement Δ appears to be sensibly independent of pressure, for it is only indirectly affected by pressure through w, the coefficient of viscosity. The author finds that this independence of Δ and pressure holds from 76 cm. down to 1 cm. For still lower pressures the agitation seemed more marked. [See Abstracts Nos. 1630 (1909) and 1652 (1911).] E. H. B.

434. *Interaction between Passing Ships.* (Nature, 88. pp. 145–146, Nov. 30, 1911.)—Gives a formula for the pressure in a liquid on the surface of which a body of oval section swims along. There are two regions of increased pressure, at the bow and stern respectively, and a region of reduced pressure abeam, extending for some distance fore and aft. When two such ovals pass each other, they will be turned towards each other on approaching, and away on receding. In shallow water the effect may be some 20 times as great as in deep water. E. E. F.

435. *Unit of Momentum.* **F. R. Barrell.** (Nature, 88. p. 144, Nov. 30, 1911.)—A suggestion that momentum should be stated as so many "sec.-dynes" (or sec.-lbs. or sec.-poundals, sec.-tons or sec.-tondals). This at once gives, with a known momentum, the *time* required for a given force to produce it, just as a known kinetic energy (sec.-dynes = ergs) gives at once the *distance* through which a given force must act in order to impart the given kinetic energy. **J. Perry** (ibid.) approves. A. D.

436. *Electromagnetic Theory of Gravitation.* **D. L. Webster.** (Amer. Acad., Proc. 47. No. 14. pp. 561–581, Jan., 1912.)—Five possible gravitational hypotheses are considered: (*a*) The changes in gravitational force due to any changes in the position of matter take place at the same instant in every point of space; (*b*) the attraction is propagated with some very large velocity; (*c*) every particle moving uniformly carries a perfectly symmetrical system of lines of force with it, but any disturbance in its motion leads to a disturbance of the lines of force which is propagated with a large velocity; (*d*) there is another vector related to the gravitational vector in the same way that magnetic force is related to electric, and a large velocity C intervenes, different from that of light c; (*e*) as a special case of (*d*), $C = c$. None but the last is consistent with the relativity principle, and it is the only one, except the practically impossible (*a*), which does not involve an extremely improbable continual increase of energy in any rotating planet, sun, or nebula. This increase is due to the radiation of "negative energy," which finds its counterpart in a "negative inertia" whose properties the author deals with in detail. E. E. F.

437. *Gravitation.* **A. C. Crehore.** (Electrical World, 59. pp. 307–311, Feb. 10, 1912.)—A charged corpuscle revolves in a circular orbit (in the plane of the paper) within the atom, with a velocity nearly equal to that of light; its electric and magnetic fields are reduced to plane sheets, rotating round the centre of the atom, equatorial to the atom, at right angles to the plane of the paper, and extending to indefinite distances. These wide-sweeping plane sheets of field are permanent concomitants of each atom; and the number of them per atom depends on the number of corpuscles orbitally circulating in each atom. Every other atom in the universe is traversed by each such sheet as the latter sweeps through space: the aggregate effect of each such sheet on the negative corpuscles traversed is *nil;* the effect on the positive sphere of the atom swept through is a momentary attraction followed at the interval of half a revolution by a momentary repulsion. The conjoined effect of these is a minute residual attraction, which accounts for gravitation. Reversing the sense of the orbital rotation leaves the resultant still an attraction.

To find the force of the residual attraction on an atom in the same plane as the orbit: Let $\mu =$ permeability of the medium, q the velocity of a moving electric charge e, $\beta = q/v$, $v =$ the velocity of light, $r =$ radius vector from centre of charged sphere to point P, $\theta =$ the angle between r and the direction of motion; then (O. Heaviside) the magnetic force at any point P is $H = \mu e q(1-\beta^2)\sin\theta / r^2(1-\beta^2\sin^2\theta)^{3/2}$. For moderate velocities take $\beta = 0$, and we have $H = \mu e q \,.\, \sin\theta/r^2$, J. J. Thomson's formula (Phil. Mag., 1881). The total induction cut by the atom traversed is $M = \int H\,dA$ from $\theta = 0$ to $\theta = \pi$ in a ring of radius r whose breadth is $2b$; $dA = 2br \,.\, d\theta$; therefore—

$$N = 2\mu eqb(1-\beta^2)/r \,.\, \int \sin\theta \,.\, d\theta/(1-\beta^2\sin^2\theta)^{\frac{3}{2}}$$

$$= -2\mu eqb/r \,.\, \cos\theta/(1-\beta^2\sin^2\theta)^{\frac{1}{2}};$$

and between $\theta = 0$ and $\theta = \pi$, this becomes $N = 4\mu eqb/r$, an expression which may also be derived from J. J. Thomson's formula *suprà.* Next, to find the electric force acting upon the positive sphere of the atom acted upon; let t be the time of transit of the plane sheet of field across the external atom; then the e.m.f. $E = (N/t)nt = Nn$, if n be the number of transits per sec.; but $n = q/2\pi a$, where a is the radius of the corpuscular orbit in the atom; whence $E = 2\mu eq^2b/\pi ar$. Conceive the external atom as a cube of side $2b$, with charge $= e'$. The magnetic plane sweeping across this has a relatively small thickness w, and acts only within a volume $4b^2w$, within which the charge is $we'/2b$. E above is the e.m.f. acting on a unit charge; the force acting on the charge acted upon is $F = Ewe'/2b = \mu q^2wee'/\pi ar = q^2wee'/K\pi arv^2$, the mechanical force upon the external atom (positive sphere) for one half revolution. During the complete revolution we have two transits, at $r = (R-a)$ and at $r = (R+a)$; and the forces are opposed at the two transits; so that the effective residual force during each complete revolution is—

$$F = \frac{q^2wee'}{K\pi av^2}\left(\frac{1}{R-a} - \frac{1}{R+a}\right) = \frac{2q^2w}{K\pi v^2} \cdot \frac{ee'}{(R^2-a^2)}.$$

Since a is relatively small, $F \propto R^{-2}$; and it also varies as q^2, the square of the velocity of the corpuscle in its orbit, that is, as the kinetic energy of the corpuscle or corpuscles in a body. Where R becomes very small, the residual attraction increases more rapidly: and in this case we should not assume the external atom to be a cube, as above, but should integrate throughout its volume. The kinetic energy of the atoms per gm. of many elementary and compound gases seems on other grounds to be nearly the same; whence the velocities q must be nearly the same, presumably about that of light.

The Gravitation-Constant.—Oxygen, *e.g.*, has 3780×10^{19} atoms per gm., and each atom 14 corpuscles; therefore $5{\cdot}29 \times 10^{23}$ corpuscles per gm. of oxygen. Taking the astronomical gravitation constant as 666×10^{-10}, the gravitational attraction A between two atoms, 1 cm. apart and containing one corpuscle each, would be $24{\cdot}6 \times 10^{-56}$ dyne. From the above formula for F, making $e = e' = 4{\cdot}9 \times 10^{-10}$ e.m. unit, $q = v$, $K = 1$, $R = 1$, and a small compared with unity, we get $F = 15{\cdot}8 \times 10^{-20}\, w$ dyne. Equating A and F, we get $w = 1{\cdot}6 \times 10^{-36}$ cm., the thickness of the magnetic plane field. From the value of N above, integrating between 0 and θ, writing $w = \cos\theta$, and finding what value of q will give 99 per cent. of the total induction within the thickness $w = 1{\cdot}6 \times 10^{-36}$ dyne above, the result is that $q = v - (8{\cdot}9 \times 10^{-55})$ cm./sec., exceedingly near the full velocity of light. The small difference in question would lead directly to the astronomical gravitation constant; and from Abraham's formula the author otherwise calculates that for calcium and carbon the difference was 10^{-74} cm./sec., while Lorentz's gave differences greater than 10^{-58} cm./sec. The thickness of the moving magnetic sheet ($1{\cdot}61 \times 10^{-36}$) is small in comparison with the corpuscle itself (10^{-13} cm.). These computations refer to orbits in the plane of the paper and moving magnetic plane fields at right angles to these, and to external atoms also in the plane of the paper. The force of gravity *for a single atom* is not uniform in all directions, but is polarised. For a congeries of atoms placed at all angles, however, the aggregate results are proportional to the results above given, as if all the particles were placed at some one mean angle; but the law of variation of the residual force with the product of the masses and with the R^{-2} will remain.

Velocity of Propagation of Gravitation.—The corpuscle travels in its orbit with a velocity q almost equal to v, the velocity of light, on its short radius a within the atom; the thin sheets of magnetic field swinging round with the corpuscles, must cross other atoms at a distance with velocities far greater than that of light; and these do not alter unless the velocities of the corpuscles within the atoms alter. This meets the demands of the astronomical problem; and the extremely rapid propagation in space of the maximum strength of field is itself a direct consequence of Heaviside's and J. J. Thomson's equations, *suprà*. A. D.

438. *Assmann Psychrometer Readings compared with Temperature Observations in Russian, French, and English Thermometer Screens.* **M. A. Rykatchew.** (Acad. Sci. St. Pétersbourg, Mém. Ser. 8. vol. 28. p. 117, 1909. Meteorolog. Zeitschr. 28. pp. 349–354, Aug., 1911.)—At the international meteorological conference at Paris in 1896 a resolution was passed to the effect that comparisons should be made in each country between the particular type of thermometer screen in use and other modes of exposure such as the French shelter on the English (Stevenson) screen, and also with an Assmann ventilated psychrometer. The author has carried out the desire of the conference at a number of Russian stations, viz., St. Petersburg, Pawlowsk, Tiflis, Ekaterinburg, and Irkutsk. At each station was installed a Russian, French, and English screen, each in the way recommended by the meteorological authorities of the country, and comparative readings between the thermometers in each screen and an Assmann ventilated psychrometer at the same level outside the screen were made at 7 a.m., 1 p.m., and 9 p.m. each

day. In general the temperature in the Russian ventilated screen when the sun was low and after sunset was slightly lower than the psychrometer dry bulb reading, the difference ranging up to 0·1° C.; while at midday the screen temperature was higher, the mean difference amounting to 0·4° C. in some months. For the unventilated Russian screen the differences were larger. The values of the relative humidity as deduced from the Russian ventilated screen by means of Sprung's formula agreed satisfactorily with those obtained from the psychrometer. For the French screen the results are similar, but the differences are greater, being more than 1° C. in some months. The relative humidity obtained from readings in the French screen was correct at 7 a.m. and 9 p.m., but was too low at 1 p.m., the difference being 6 per cent. in Feb. Small trees were subsequently planted around the screen in accordance with the French instructions, and they were found to reduce the differences to a marked degree. The English screen gave values for midday temperature in better agreement with the psychrometer than either of the other screens, and in the morning and evening the error in the readings was only slightly greater than that of the Russian ventilated screen. The English screen thus furnished the best exposure for the thermometers. The author recommends that it be made larger, so as to accommodate a hair hygrometer; and that it be raised somewhat, so as to diminish local radiation effects from the ground. R. C.

439. *Propagation of Warm Waves in European and Asiatic Russia.* **H. v. Ficker.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 745–836, June, 1911.)—In continuation of his researches [see Abstract No. 278 (1912)], the author deals with warm waves. The lines joining spots of simultaneous temperature-rises are, on the whole, meridional, but may be strongly curved, and warm and cold currents may then proceed on parallel paths. The general drift of the currents is eastwards. Most warm waves are preceded and followed by cold waves. From the warm areas islands or tongues extend into the cold areas. The winds bringing warm weather mostly blow from the south-west fairly in the direction of the warm wave (not at right angles to it, as with cold waves). The temperature maxima differ with warm waves much less from one another than with cold waves. Sometimes a warm wave may be traced from the Atlantic and Arctic shores right over to Eastern Siberia; but generally they vanish before they cross Lake Baikal. The rate of propagation is about 33 km./hour, about the same rate as that of the cold waves, and the two kind of waves are probably interconnected. The humidity observations suggest that the warm currents hail from the ocean. The abnormal heating of continental areas is as a rule confined to shallow surface strata. Warm waves develop mostly in the front of a depression, and cold waves in the rear of the depression, whose centre generally lies near the polar boundary of the warm area; these depressions consist of two neighbouring currents of different temperatures. It would appear in general that the warm south-westerly winds are always blowing as part of the general circulation, and that they are temporarily lifted from the surface and pressed upward by the invasion of cold waves, which likewise belong to the general circulation. The phenomena are simpler in Russia than elsewhere because the temperature variations are more pronounced there, though caused by abnormal temperatures in relatively shallow strata. H. B.

440. *Diurnal Range of Pressure in the Ground.* **R. Börnstein.** (Phys. Zeitschr. 12. pp. 771–776, Sept. 15, 1911. Meteorolog. Zeitschr. 28. pp. 561-

566, Dec., 1911.)—In order to investigate the question of the transference of air to and from the ground, which is suggested by observations of atmospheric electricity, arrangement was made for the continuous registration of the pressure in the ground at a depth of 1 m. A tube of German silver was embedded in the ground, having its lower end open at 1 m. below the surface and its upper end connected hermetically with the open tube of a mercury barometer. Thus the reading of the barometer gave the pressure at 1 m. depth. Floating upon the surface of the mercury column in the closed tube of the barometer was a piece of iron enclosed in glass, and the motion of the float was communicated to a recording pen writing on a revolving drum, through the agency of a magnet supported by means of a counterpoise just outside the barometer tube opposite the float. Care was taken to keep the barometer at a uniform temperature. The records obtained were compared with those from a neighbouring barograph recording air pressure in the usual way. The mean diurnal variation for each of the months March to June was formed in the two cases, and curves showing the variation are reproduced for each of the months. The character of the daily variation is the same in the earth as in the open air; that is, there are two maxima, at about 10 a.m. and 10 p.m., and two minima at about 4 a.m. and 4 p.m. The amount of the variation is different in the two cases; as compared with free air pressure, the pressure in the ground is high at 10 a.m., and low at 4–6 a.m. and 10 p.m., while at 4 p.m. the two values are about equal. The times of maxima and minima are scarcely affected, but the tendency is for them to occur a little later in the ground. R. C.

441. *Weather of* 1911. **W. N. Shaw.** (Nature, 88. pp. 141–142, Nov. 30, 1911.)—Apart from the prevalence of anticyclones in a particular direction, or the continuance of given winds, it is possible that the distribution of pressure is not in itself a complete explanation of the weather. Whereas the pressure distribution is controlled in the upper air, beyond 9–10 km., the presence or absence of rain is largely due to the convection of moist air in the lower atmosphere. Throughout 1911 there were many occasions when there should have been rain according to the pressure distribution, yet the expected showers did not come. Observations from balloon instruments show that the pressure variations above 9 km. are practically equal to those at the surface, and as the surface layers are continually varying in temperature and humidity, it is useless to attempt the explanation of the outlines of pressure distribution by discussions of surface conditions. **W. H. Dines.** (Ibid. p. 175, Dec. 7, 1911.)—From a series of 18 records of the temperature up to 15 km., it is found that the heat was confined to the lower strata. Information about the relation of temperature at a given height is to be obtained from a discussion of 200 ascents. **C. Ramsauer.** (Ibid. p. 212, Dec. 14, 1911.)—Ascribes the abnormal absence of rain to the scarcity of condensation nuclei, possibly due to the decreased ultra-violet solar radiation. **W. H. Dines, A. Schmauss, and J. I. Craig.** (Ibid. 88. p. 348, Jan. 11, 1912.)—Lists of correlation coefficients are given, showing the possible relationships between various atmospheric phenomena, and attention is drawn to the risk of utilising data of low correlation. C. P. B.

442. *Ground Temperatures in Belgrade.* **P. Vujević.** (Glas Srpske Kraljevske Akademije, Belgrade, 79. pp. 95–177, 1909. Meteorolog. Zeitschr. 28. pp. 289–301, July, 1911. Extract.)—A very complete installation of 25 earth thermometers for determining temperatures at depths up to 24 m.

below the surface was arranged at Belgrade in 1902. Nine of the thermometers (from 0·01 m. to 0·6 m.) are read hourly. Four (from 0·9 to 2 m.) are read four times a day, and the remainder once a day. The results are for the period 1902–1906. The level of underground water is 11 m. The mean diurnal range of temperature varies from about 8° C. at 1 cm. to ½° C. at 30 cm., and zero below 70 cm.; while the times of occurrence of the maxima and minima show a progressive retardation with increase of depth, being 2.15 p.m. and 5.40 a.m. at 1 cm., and 12.50 a.m. and 2.15 p.m. at 30 cm. At 60 cm. the corresponding epochs are 2.30 p.m. and 2 a.m. respectively, *i.e.*, nearly the same as at the surface, the retardation amounting to about 24 hours. Conditions in Jan. are characterised by small diurnal range in the upper layers only, those below 50 cm. showing no diurnal variation; while in July the diurnal range is nearly three times as great, and it extends to greater depths. In Jan. the temperature at 20 cm. is practically constant throughout the day, and equal to 1° C.; while below 20 cm. it rises steadily. Above 20 cm. temperature falls during the morning and late evening hours; in the afternoon there is a minimum at 10 cm. At the surface the maxima and minima are about 1° C. and − 0·8° C. In July diurnal range at 50 cm. is small, the temperature there being just over 22° C., and diminishing slowly with increase of depth. Above that level there is a maximum of about 23° C. at 30 cm., from 1 a.m. to noon. At the surface the maxima and minima are about 31° C. and 20° C. The seasonal variation has to do with much greater depths than the diurnal variation. Its change with depth resembles that of the latter, and shows retardations of times of maxima and minima. At the surface these occur in July and Jan., at 2 m. in Sept. and March, at 8 m. in Jan. and June, at 12 m. in May and Nov.; at 14 m. there is no variation. The amplitudes of the seasonal variation diminish steadily with depth, the maxima decreasing from 25° C. at the surface to 12·9° C. at 14 m., the minima increasing from 0·15° C. to 12·9° C. From 14 m. to 24 m. the temperature increases to 13·3° C., the rate of increase below 18 m. being constant and equal to 0·05° C. per metre. R. C.

443. *Evaporation from Swiss Lakes during the Drought of* 1911. **J. Maurer.** (Meteorolog. Zeitschr. 28. pp. 545–555, Dec., 1911.)—Observations were made from June to Sept. on the Lake of Zürich and on the Greifensee near it by the hydrometric method, first tried by R. Lauterburg on the Lake of Zürich in 1868, who found an evaporation of 30 mm. per day, evidently much too high a figure. The actual observations, most of which were taken by H. Mettler, concern the amount of water flowing into the lakes, the water discharged from the lakes, the water-levels in the lakes, and the rainfalls. The resulting evaporation is estimated at 4·7 mm. per day for the Greifensee, and at 4·6 mm. per day for the Lake of Zürich; during the hottest period, July 16 to Sept. 15 (62 days), each lake lost about 300 mm. of water. Assuming those climatic conditions to continue for 8 or 10 months, the annual evaporation would be from 1500 to 1600 mm. S. Tomlinson's observations (1894) at the Bombay Waterworks yielded 1587 mm. H. B.

444. *Oscillations of the Sea off Sicilian Coast* (*Sea-seiches*). **G. Platania.** (N. Cimento, 2. Ser. 6. pp. 349–359, Nov., 1911.)—The tidal curves given by self-recording instruments in general do not run smoothly, but present minor fluctuations or "dentellures," produced by rhythmic oscillations of the sea, having periods of only a few minutes. Such oscillations are known, from the analogy with similar phenomena of lakes, as *sea*-seiches. At some places and seasons, these oscillations are so small that they are scarcely noticeable, even on the mareogram records, but at others they are of notable intensity, and may even be dangerous to navigation. The local names for such movements are *yola* and *abiki* in Japan, *empifondi* on the Ligurian coast, *marrobbi* in Sicily. In the latter region they are especially prominent near Mazzara and Marsala, in the western parts of the island, and the author, thinking they deserved a particular attention in the light of modern researches on seiche phenomena, undertook the examination of a number of mareograms from different ports. During 1905, observations were simultaneously made at various stations, several very strong oscillations being particularly noticeable. At Lampedusa the observations were continued for a number of years; it was found that the most prominent "seiches" coincided in time with notable barometric depressions. The investigations of Honda, Terada, and Isitani have shown that a group of longitudinal waves travelling in the direction of the length of a bay, and reflected at its extremity, will produce by interference a stationary wave. If the wave-length be such that a node is formed at the entrance of the bay, the periodic time is in general equal to that of the fundamental oscillation in a basin of double its length, or $T = 4l/\sqrt{gp_m}$, where l is the length of the bay, measured in direction of probable propagation of wave, p_m the mean depth, and g the acceleration due to gravity. The necessary corrections and the investigations of Chrystal are considered [Abstract No. 1578 (1910)], also the formulæ of Merian, Du Boys, and Endrös. Though the results of observation varied considerably on the whole, a short period of 12–15 minutes, agreeing fairly well with the theories of Chrystal and Endrös, came out; also a longer period of 21–26 minutes was sometimes noticeable. The latter oscillations, according to Börgen, may perhaps be considered as "summation waves" analogous to the "summation tones" of Helmholtz. The researches of Harris (*Manual of Tides*), who distinguishes six classes of seiches, of which the *cul-de-sac* seiche and shelving seiche are generally observed on open coasts, are also referred to. The earthquakes of Calabria in 1905 and Messina in 1908 were accompanied by "*maremoti*" of periods equal to those of the ordinary seiches, which seem in general due to wind, rapid variations in atmospheric pressure, &c. F. W. H.

445. *Earthquake Surface-waves.* **B. Galitzin (Golicyn).** (Acad. Sci. St. Pétersbourg, Bull. No. 2. pp. 219–236, Feb. 1, 1912.)—A mathematical paper on the dispersion and damping of seismic surface-waves. The author has introduced into the fundamental differential equation of the elastic theory a term which represents a frictional force proportional to the velocity of displacement of a mass-element, and discusses the consequences. These are shown to be in harmony with the results of direct seismic measurements. The surface earthquake waves are to be regarded as damped vibrations, the damping being stronger in the case of waves of smaller period. A. D. R.

446. *Ratios of the Rare Gases in Natural Gases from Coal-mines.* **C. Moureu** and **A. Lepape.** (Comptes Rendus, 153. pp. 1043–1045, Nov. 20, 1911.)—In continuation of their researches [compare Abstracts Nos. 1091 and 1658 (1911)] the authors determine the volume ratios of argon, krypton, xenon, and nitrogen in natural gases from coal-mines; how the "grisous" were collected is not explained. The ratios A/N, &c., taking the ratio of A/N in air as unit, are smaller than those observed in other natural gases, especially in the Lens Colliery, indicating perhaps that the crude argon (*i.e.*, mixture of inert gases) has undergone a selective absorption in diffusing through the coal which would tend to reduce the percentage in heavy gas. Helium does not, in this respect, show any more regularity in coal-mine gas than it does in other natural gases. H. B.

447. *Decomposition of Water by Solar Rays.* **M. Kernbaum.** (Acad. Sci. Cracovie, Bull. 10a. pp. 583–586, Dec., 1911.)—Some oxygenated water (H_2O_2) is found in rain and snow, particularly during the daytime, but not in dew. If light could decompose water according to $2H_2O = H_2O_2 + H_2$, this occurrence would be explained, and the higher atmosphere should contain hydrogen. The demonstration that sunlight remains strong enough in ultra-violet rays to decompose water on the surface of the earth succeeded during the hot July of 1911 near Paris. 50 cm.^{3} of boiled water were exposed to the sun's rays in a quartz bulb which was joined to a Gaede pump and the rise in the vapour-pressure was observed, some water being introduced into the mercury of the U-gauge to compensate for the saturated vapour-pressure. There was a slight rise, which stopped after some days, probably because the rays produce also recombination; the rise amounted to 5 mm. after five days, and was stronger when some air was present in the water. H. B.

448. *Proportion of Carbon Dioxide in the Antarctic Atmosphere.* **A. Müntz** and **E. Lainé.** (Comptes Rendus, 153. pp. 1116–1119, Dec. 4, 1911.)—Thirty years ago Müntz and Aubin found on average 2·74 parts by volume of CO_2 in 10,000 parts of air. Near Cape Horn, however, the percentage was lower, 2·21 sometimes. According to T. Schloesing the CO_2 of the atmosphere is the result of the dissociation of bicarbonates in sea-water, which would contain 10 times (27 times according to Krozh) as much CO_2 as the air, and the vapour tension of CO_2 should in the cold Arctic seas be smaller than in warmer latitudes. During the Charcot expedition air samples were collected between Lat. 64 and 70° S., not as previously with the aid of potash tubes of 300 litres' capacity, but by letting evacuated crystal vessels of 3 litres' capacity fill themselves with air after breaking off their sealed points. The mean content of CO_2 found was 2·05 parts per 10,000, the minima of 1·4 and 1·7 occurring in the highest latitudes. If these figures be correct, the ordinary atmospheric circulations cannot suffice to effect a uniform composition of the atmosphere. H. B.

449. *Constitution of the Solar Corona.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 72. pp. 139–150, Dec., 1911.)—Working on the theory of the electronic constitution a series of systems are computed which are found to account for 14 out of the 22 lines known to be in the corona spectrum. Tables are given showing the various lines, with the degrees of positive or negative charge appertaining to each. The average divergence of the computed from the observed wave-lengths is about 4 tenth-metres. C. P. B.

450. *Photoelectric Measurement of Solar Radiation.* **G. Raymond.** (Comptes Rendus, 154. pp. 45–47, Jan. 2, 1912.)—The usual observations of solar radiation with a polished mirror are necessarily affected by the variations of polish of the reflecting surface, and a method has been devised whereby this difficulty is avoided. The receiver is a surface of zinc amalgam, which can be instantly renewed before the observation, and is practically constant for a definite composition of the amalgam. The sensitivity depends on the percentage composition and may be raised to suit the other apparatus. Tables are given showing the monthly values of duration of discharge, with a note of the state of the sky as regards cloudiness. The effect appears to vary with the altitude of the sun, and shows minima in Jan. and maxima in July. C. P. B.

451. *International Solar Research.* (Internat. Union for Co-operation in Solar Research, Transactions, Vol. III. Extract by C. P. Butler, in Nature, 88. pp. 292–293, Dec. 28, 1911.)—The article is a review of the principal contents of the volume containing the transactions at the meeting of the Solar Union at Mt. Wilson in 1910. The new sun-spot map in preparation at the Solar Observatory is to be on a scale not less than 5 mm. to 1 Å., and for convenient reference the separate sections are not to exceed 60 cm. in length. G. E. Hale gave a detailed description of the new tower spectrograph, with image lens of 150-ft. focal length, and spectroscope 75 ft. focal length. In the photography of solar eruptions with the spectroheliograph it is found that Hα is more useful than the Ca lines H and K, and these phenomena appear to be intimately connected with terrestrial magnetic storms. The Wave-length Committee reported that in the near future a trustworthy table of wave-length standards on the International scale would be available, based on the "*secondary standard*" iron lines. From an exhaustive series of pyrheliometric determinations at Washington (sea-level), Mt. Wilson (1800 m.), and Mt. Whitney (4420 m.), Abbot concludes that the solar constant is 1·95 cals. per sq. cm. per min. In future all position angles on the sun's limb are to be reckoned from the North through East, South, and West from 0° to 360°. It was announced that in all probability a solar observatory would be established in Japan in the near future. C. P. B.

452. *Brightness of the Moon's Phases.* **A. Scheller.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 889–921, June, 1911.)—Discussion of an elaborate series of observations of the photometric determination of the variation of brightness of the moon throughout its phases. The results are tabulated and also plotted to show the light-curves of variation. Comparisons of the value for full moon are given for the results of other observers. C. P. B.

453. *Optical Resolution of Saturn's Ring.* **D. P. Todd.** (Amer. Journ. Sci. 33. pp. 152–154, Feb., 1912.)—After summarising the historical observations of the ring system of Saturn, ending with Keeler's spectroscopic demonstration that the rings are composed of numerous small particles revolving round the planet in definite orbits, the author describes various attempts he has made to see the individual particles visually. The chief factor rendering this observation difficult is the atmospheric disturbance of the definition, and by carefully taking advantage of specially good seeing conditions during the autumn of 1911 the author claims to have seen the ring constituents. On Oct. 28 and 29 powers of 950 and 1400 could be used with an aperture of 16 in., and near the extremities of the inner bright ring a sparkling flocculence was glimpsed. The appearance is stated as being similar to that presented by fine snowflakes illuminated by the sun at the close of a storm. A telegram in Latin was dispatched to Europe announcing the "*optical resolution*" of the ring, but from its wording it was translated as "*optical dissipation*," and was interpreted as indicating the disruption of the ring system. C. P. B.

454. *Planetary Atmospheres.* **Arrhenius.** (Publications de la Société de Chim. Phys. Nature, 88. p. 292, Dec. 28, 1911. Abstract.)—Starting with each planet as a separate portion of the supposed original solar nebula, the general method of evolution is traced, whereby the metals, hydrocarbons, &c., gradually become parts of the planet's surface. CO_2 would be the most resistant impurity of the atmosphere, and would be subsequently again produced by volcanic action. C. P. B.

455. *Spectra of the Outer Planets.* **O. Büry.** (Astronom. Nachr. No. 4537. Nature, 88. p. 190, Dec. 7, 1911. Abstract.)—The author finds the characteristic absorption spectra of the outer planets may be explained by the combination of Chappuis' and Schöne's ozone spectra with the spectra of the higher oxides of nitrogen. C. P. B.

456. *New Comet of Short Period.* **G. Fayet.** (Comptes Rendus, 154. pp. 53–54, Jan. 8, 1912.)—A very faint comet was discovered by Schaumasse on Nov. 30, 1911, with the equatorial coudé of the Nice Observatory. From the elements computed it is seen that this comet is specially interesting on account of its very short period, only 7 years.
C. P. B.

457. *Photographic Determination of Differential Star-places.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 72. pp. 91–110, Dec., 1911.)—In a previous paper [Abstract No. 1098 (1911)] an outline was given of two proposed methods by which differential star places could be determined photographically. A modified procedure is now described in which the use of chronographic registration is dispensed with, and the photographs taken with an ordinary photographic equatorial, such as the astrographic type of instrument available in many observatories throughout the world. Many consecutive regions of the same declination and hour angle are obtained on the same plate, with a considerable overlap between each pair. The mean differences between exposures give the scale value and orientation for known stars near the beginning and end. The system provides a powerful scrutiny for discussion of systematic errors. As evidence of the accuracy possible, the analysis of the results has brought out evidence that the magnitude equation of the Cambridge meridian observations changed character about 1879. C. P. B.

458. *Radial Velocities and Spectral Types of Stars.* **W. E. Rolston.** (Nature, 88. pp. 424–425, Jan. 25, 1912.)—A review of recent work by Campbell at the Lick Observatory, and Ludendorff in Germany, dealing with the discussion of variations of radial velocity in relation to spectral type. Taking the average velocities of the different types outlined in the Harvard Classification, Campbell found an outstanding error in the case of the helium (class B) stars. No reason is at present known which can satisfactorily account for this, but it is suggested by Campbell that in different stars the absorption may take place at different pressures, or that the distribution of intensity in the width of the He lines (which are known to be double) may affect the measurements. Ludendorff selects from Campbell's list of 224 stars all those with velocities greater than 8 km., whether of recession or approach, and, comparing them with the Kensington Classification, finds indications that the ascending and descending stars

appear to have positive and negative velocities respectively. If this is real some support is given to Campbell's idea that the He wave-lengths depend on the conditions of each star's atmosphere. C. P. B.

459. *Photographic Study of Structure of Galaxy.* **A. Pannekoek.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 579–584, Jan. 24, 1912.) —One of the chief difficulties encountered in the study of galactic structure has been the personal differences involved in the visual star countings. Owing to this the fluctuations of star density may be considerable, even in small regions. A number of methods are outlined whereby the data may be obtained from specially taken photographic records, which have the advantage that they can be measured by several persons, and are always available for subsequent check. Special plates for testing these proposals have been made by Hertzsprung at the Potsdam Observatory with a Zeiss triplet of 150 mm. aperture and 1500 mm. focal length. Each plate can be used to cover a portion of the heavens of more than 25 square degrees. C. P. B.

460. *Distribution of Stars according to Spectral Type.* **K. G. Hagström.** (Kungl. Svenska. Vetenskaps. Akad. Handlingar, 46. No. 7. Nature, 88. p. 226, Dec. 14, 1911. Abstract.)—An analysis of the distribution of various stars indicates that those with fifth-type spectra are concentrated about the Milky Way, and the Orion stars more in the southern than the northern hemisphere; for solar and first-type stars there appears to be no particular grouping. C. P. B.

461. *Milky Way and Star Streams.* **J. C. Kapteyn.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 524–530, Dec. 28, 1911.)—The author has in previous papers given the conclusion that in passing from the stars of spectral type B (helium stars) to those of the type A (Sirius stars), and from these to solar stars (type G) there is a gradual change in the direction of the streams. There is also evidence of changes in the velocities. The idea is that originally there were two streams, but that in the course of evolution the directions and velocities have been so modified that the oldest stars have deviated most, and the youngest least, from the original values. The motion of the two streams of G stars relative to the centre of gravity of all the stars is perfectly parallel to the plane of the Milky Way. It is now an accepted fact that the proper motions of the helium stars are small, and the inference is that their distance must be considerable. C. P. B.

462. *Formation of Star Streams.* **B. Boss.** (Astronom. Journ. No. 629. Nature, 88 p. 189, Dec. 7, 1911. Abstract.)—The idea of a controlling electromagnetic field is formulated to explain the formation of a star stream of 71 stars recently investigated. If the nebulæ are loci of ionisation forces, a relatively strongly polarised mass will become expelled from the matrix and start its life-history as a star. Initially the directions of movement might be haphazard, but the actions of the magnetic field would tend to bring the polarised masses approximately parallel to the field lines. Assuming the B (Harvard Classification) stars to be the newest or youngest, this agrees with the above theory, and further, the stars showing community of motions are found to be of types F, G, K. C. P. B.

463. *Peculiar Variable Star.* **E. C. Pickering.** (Harvard College Observatory Circular, 168. Nature, 88. p. 327, Jan. 4, 1912. Abstract.)—The star 232848 Z Andromedæ exhibits light-changes of a specially peculiar nature. From 1889 it showed oscillations of brightness from 11·5 to 9·7 magnitude ; in 1901 it rose to 9·2, and for the last six years has been nearly constant at 11·0 An examination of the spectrum by Miss Cannon shows that it resembles that of a nova; in addition to the bright lines H_β, H_γ, H_δ, H_ϵ, due to hydrogen, there is a line at λ4688, which probably corresponds with the bright band in the spectra of fifth-type stars. C. P. B.

464. *Systematic Motions of the Stars.* **L. Boss.** (Science, 35. pp. 220–221, Feb. 9, 1912. Abstract of paper read before the Amer. Assoc. for Advancement of Science.)—About six years ago meridian astrometry was instituted at the Dudley Observatory with the object of determining the proper motions of the brighter stars, and two years ago a preliminary catalogue of 6188 stars was published. Interesting facts were given about the moving cluster of stars in Taurus. Later Frost, Kapteyn, Campbell, and the author have given results of the interdependence of stellar velocities and spectra. Arranging the velocities in order of magnitude, it is seen that the order is the same as that for the spectral type, ranging from B (the youngest) to M (the oldest). The variation appears to indicate that the motion of a star accelerates up to about the time the spectrum develops into type F or G, after which it seems to gain no increase of velocity. Considerations are given in support of the belief that an ellipsoidal arrangement of the universe as suggested by Schwarzschild would be reduced to a simple and natural explanation, if it be supposed that the stars had been originally formed in nebulæ and repelled from the regions of their formation. C. P. B.

465. *Spectra of Iron-flame, Sun-spots and Lower Type Stars.* **J. N. Lockyer.** (Roy. Soc., Proc. Ser. A. 86. pp. 78–80, Dec. 22, 1911.)—The winged iron lines in the sun-spot spectrum are in general the lines special to the flame spectrum, and Adams has shown that in the case of arc spectra, the lines relatively much stronger in the flame of the arc are those most affected in sun-spots. To enable comparisons to be made without the action of the arc, arrangements were made by H. A. Harker and C. P. Butler to photograph the spectrum of iron as given by a powerful electric furnace at the National Physical Laboratory. From these spectra it is evident that the lines which exist at the lowest temperature of the furnace, are those occurring in the oxyhydrogen flame spectrum. The behaviour of these special lines in passing from the solar spectrum to that of Arcturus and α Orionis has been studied. In the more refrangible portion of the spectrum from λ4330 to λ4000, the flame lines appear to be mainly unaffected in passing from the solar spectrum to that of Arcturus. In the region λ4330 to λ4500 most of the lines are strengthened in both Arcturus and α Orionis. C. P. B.

466. *Distances of Spiral Nebulæ.* **M. Wolf.** (Astronom. Nachr. No. 4549. Nature, 88, p. 494, Feb. 8, 1912. Abstract.)—Making the assumption that many of the spiral nebulæ systems are of intrinsically the same dimensions, the author calculates the distances from the parallaxes and the diameters from the measured angular diameters combined with the distances. Several typical instances are tabulated. C. P. B.

467. *The Hard and Soft States in Metals.* **G. T. Beilby.** (Inst. of Metals, Journ. 6. pp. 5–43, 1911. May Lecture. Engineering, 91. pp. 660–661, May 19, 1911.) [See Abstracts 2506B (1904), 2019 (1905).]

468. *Strength of a Single-wall Piston.* **T. Matsumura.** (Coll. Sci. Engin., Mem. Kyōtō, 3. pp. 223–245, Jan., 1912.)—Mathematical. An extension of Grashof's theory for a flat circular plate of uniform thickness. L. H. W.

469. *Initial Yield in Gyroscope.* **W. S. Franklin.** (Phys. Rev. 34. pp. 48–52, Jan., 1912.)—Discusses how much a structure steadied by a gyroscope *yields* to a disturbing force, *while* the precessional motion is being established that will presently right the structure again. E. H. B.

470. *Primary Concepts of Physics.* **W. F. Magie.** (Science, 35. pp. 281–293, Feb. 23, 1912. Address delivered before the Amer. Physical Soc., and Section B of the Amer. Assoc. for Advancement of Science, Washington, Dec. 28, 1911. Phys. Rev. 34. pp. 125–138, Feb., 1912.)—A lucid semi-popular *résumé* of Newton's definitions and laws of motion and the criticisms passed upon them, followed by a discussion of the principle of relativity which the author views with grave doubts. E. H. B.

471. *On a Theorem in Statistical Mechanics.* **F. Hasenöhrl.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 923–936, June, 1911.)—Mathematical.

472. *The Law of Molecular Attraction.* **D. Tyrer.** (Phil. Mag. 23. pp. 101–113, Jan., 1912.)

473. *Theory of Pendulum with Elastic Thread.* **M. K. Grober.** (Deutsch. Phys. Gesell., Verh. 14. 3. pp. 145–158, Feb. 15, 1912.)

474. *Collapsing of Curved Beams and Curved Elastic Strips.* **L. A. Marbec.** (Inst. Naval Architects, Trans. 53. pp. 233–251, 1911.)

475. *Results of Experimental Tank Tests on Models of Submarines.* **M. S. Chace.** (Inst. Naval Architects, Trans. 53. pp. 61–68; Discussion, pp. 69–70 and 351–352, 1911. Engineering, 92. pp. 64–69, July 14, 1911.)

476. *Further Notes on Cavitation.* **S. W. Barnaby.** (Inst. Naval Architects, Trans. 53. pp. 219–226; Discussion and Communications, pp. 226–232, 1911. Engineering, 92. pp. 55–56, July 14, 1911.)

477. *The Acceleration in front of a Propeller.* **R. E. Froude.** (Inst. Naval Architects, Trans. 53. pp. 139–153; Discussion and Correspondence, pp. 153–171, 1911. Engineering, 91. pp. 499–503, April 14, 1911.)

478. *A Method of measuring Absolute Viscosity.* **H. P. Gurney.** (Amer. Chem. Soc., Journ. 34. pp. 24–28, Jan., 1912.)—The method consists simply in drawing the liquid up into a capillary tube (by connecting it with an exhausted flask) and allowing it to flow out under the pressure of its own weight. No measurements are given, but the formula for obtaining the absolute viscosity is worked out. A. F.

479. *Origin of Trombes.* **A. Wegener.** (Meteorolog. Zeitschr. 28. pp. 201–209, May, 1911.)

480. *Mechanics of Wind Squalls* (*Böen*). **W. Schmidt.** (Meteorolog. Zeitschr. 28. pp. 355–362, Aug., 1911.)—[See also Abstract No. 276 (1912).]

LIGHT.

481. *The Universal Metalloscope.* **A. Sauveur.** (Amer. Inst. Mining Engin., Bull. 60. pp. 961–971, Dec., 1911.)—The microscope tube provided with the usual adjustments is mounted 5 in. above the table on a bar 12 in. long, supported at the ends on cast-iron legs, thus allowing ample free space for the examination of bulky specimens. The stage is separate and in the form of a powerful electromagnet mounted on three legs, steel templates with V-shaped openings being provided for the accommodation of small specimens. Non-magnetic specimens are attached by means of rubber bands to steel holders. Both the stand and stage are mounted on levelling screws, while the motion of the stage is aided by mounting the back leg under the solenoids, on a swivel wheel running in a groove cut in a brass plate fixed to the table. Mechanical stages are also provided, one for attachment to the electromagnetic stage (horseshoe type), and another mounted on a separate horseshoe base and fitted with the accessories for examination of transparent specimens by transmitted and polarised light. F. C. A. H. L.

482. *Prevention of Dew Deposit on Glass Surfaces.* **J. Franklin-Adams.** (Roy. Astronom. Soc., M.N. 72. pp. 165–167, Dec., 1911.)—In order to prevent the deposition on the glass surface of telescope objectives open to the air, a system of jets of specially purified and dried air is arranged to impinge on each side of the object-glass. A drawing is given showing the various pieces of apparatus in the equipment. C. P. B.

483. *Measurement of the Speed of Photographic Stops.* **G. C. Trabacchi.** (Accad. Lincei, Atti, 20. pp. 701–705, Dec. 17, 1911.)—In the apparatus, which is fully described, the main portions are a beam of either sunlight or light from an electric lamp, which in its course passes through holes in two sheets of Al placed one behind the other. After passing through these holes the light is focussed by a lens upon a screen or plate. The lens also has a motion of its own. The front piece of Al being attached to one prong of a tuning-fork of known frequency it is possible to interrupt the ray at regular known intervals. Photographs of results obtained with a Thornton-Pickard shutter are given, and measured speeds with that class of shutter and also with that of Büttner are compared with the speeds as indicated. A. E. G.

484. *The Latent Image.* **W. D. Bancroft.** (Journ. Phys. Chem. 16. pp. 29–68, Jan., and pp. 89–125, Feb., 1912.)—A continuation of the series of papers [see Abstracts Nos. 891, 936 (1910), and 222, 1018, 1359 (1911). Here the views of Carey Lea, as to photohalides forming the latent image and being of the nature of solid solutions of mixed silver halides, those of Lüppo-Cramer to a similar effect (latent image due to absorption of silver in silver halide), and those of Reinders (solid solution of colloid silver in silver haloid) are quoted at length, together with their results as to the photo-reactions of the photohalides themselves. The next paper of the series is to contain a discussion of the theory of the latent image from a single point of view. A. D.

485. *Variation of Photographic Gradation.* **Rayleigh.** (Phil. Mag. 22. pp. 734–740, Nov., 1911.)—In copying by photography the procedure usually involves two processes: (1) The making of a negative, and (2) the making of a positive from (1). It is evident that as ordinary photographic results are in monochrome, the reproduction can only be complete when the original is of the same colour. After making an analytical formulation of several types of reproduction, the chief conclusion is employed to introduce suggestions for the problem of obtaining increased contrast on pictures originally showing very little contrast. A typical instance is the delineation of the solar corona, which is much hampered by the presence of atmospheric sky glare. By making a series of positives, any one of which separately may show slight trace of image, and, superposing them, it may be found possible to bring up the details of the special image in spite of the general light passed by the background. Tests of the method by means of a portrait picture diluted by an exposure to light on every positive showed a very decided increase of contrast. Another method tried was to intensify the positive, this being also successful. C. P. B.

486. *Slagmatype: A New Printing Process.* **H. Strecker.** (Zeitschr. Elektrochem. 18. pp. 18–22, Jan. 1, 1912.)—By mixing in definite proportions suitable solutions of gum arabic and gelatine an emulsion is formed in which small globular masses of gum or gelatine separate out in a regular manner, according as the one or other is in excess. A copper plate is coated with such an emulsion in which the gum is separated out. This has previously been chromated to render it sensitive to light after being dried on the plate. The separated gum-drops act towards the bichromated gelatine in such a manner that half-tone results can be obtained without using a line screen. The etching may be carried out by a purely chemical process produced by immersion in several baths of iron chloride, or electrolytically in one bath of a suitable neutral concentrated salt solution. It is claimed that this process is simpler than that commonly practised, and is universally applicable, while the final print obtained is artistic. A. E. G.

487. *Artificial Rotatory Polarisation.* **A. W. Ewell.** (Phys. Rev. 33. pp. 480–491, Dec., 1911. Phys. Zeitschr. 13. pp. 100–104, Feb. 1, 1912.)—A twisted jelly cylinder shows rotatory polarisation, the rotation being opposed to the twist [Abstract No. 52 (1900)]. It is independent of the distance of the beam from the axis of the twisted cylinder, but decreases with increasing obliquity. It is increased by enclosing the jelly within a tightly fitting rubber tube; it is independent of hydrostatic pressure; decreases with rise of temperature, and usually exhibits mechanical and optical relaxation effects. The rotation of rubber-covered jelly cylinders is proportional to a high power of the twist, the mean value of this power being approximately 4, and the rotation increases with longitudinal compression. The most satisfactory jelly consists of 1 gm. gelatine to 4 c.cm. of water, and 8 c.cm. glycerine. To make the rubber-covered cylinders, a circular glass plate which had been cemented to one end of a slightly smaller threaded brass tube was inserted into each end of a slightly smaller tube of pure gum rubber. Wire bands secured the jelly and brass tubes. Melted jelly was poured into the tube through a slit in the side, and the jelly was allowed to solidify while the tubes were held in alignment. A jelly cylinder 4 cm. long, 0·6 cm. in diam., with a rubber envelope 0·175 cm. thick, traversed by light of wave-length 4480, gave a rotation of 4 deg. with a twist of 50°, 9 deg. with a twist of 90°, and 67 deg. with a twist of 150°. The rotation is approximately proportional to the square of the diam., and inversely proportional to the square of the length and of the wave-length. As regards theory, a twisted cylinder with a distorted cross-section may be considered as composed of similar, infinitely thin, doubly refracting plates, the principal section of each plate being rotated through an infinitely small angle. It is shown that the mean rotation, in radians, is equal to half the area of a segment of a circle whose angular aperture is twice the angle of twist, and the length of whose arc is the angular difference of phase. This results in the above relations with regard to the diam. length, and wave-length. Special apparatus was devised for studying the double refraction, which is more complex than the optical rotation. E. E. F.

488. *Magneto-optic Effects in Chlorine and Iodine.* **A. Heurung.** (Ann. d. Physik, 36. 1. pp. 153–176, Oct. 3, 1911. Dissertation, Würzburg.)—Light was dispersed and transmitted through a long tube of Cl surrounded by powerful magnetising coils. No sensible increase of the magneto-optic relation could be observed in the absorption bands. In the case of iodine vapour the absorption spectrum was compared with the brightening of the field with crossed nicols in a magnetic field. A number of new lines appeared on exciting the magnetic field. The brightening could not be annulled either by turning the analyser or by means of a quarter wave-plate, so that only a small portion of the light can be regarded as polarised. By means of an echelon grating the single absorption lines were obtained very sharply, but no change was observed in the magnetic field, though a few lines brighten up between crossed nicols. The effect in a transverse field is in the same sense, but much feebler. E. E. F.

489. *Influence of the Solvent on the Position of Absorption Bands in Solutions.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 86. pp. 15–20, Dec. 22, 1911.)—Kundt concluded that the effect of the solvent was to displace the absorption bands further towards the longer wave-lengths, the greater the refractive or dispersive power of the solvent. Later experiments have shown that this rule is not sufficient, as physical or molecular changes introduce complications. A definite formulation of Kundt's rule is here given, obtained by using a suitable type of dispersion formula, allowing in some cases a numerical estimate to be formed of the effects which can be ascribed to its operation. Recent researches, however, point to the formation of molecular aggregates as a chief cause of variation in the absorption spectra of the same salt in various solvents. A. W.

490. *Arc and Spark Spectra of Radium.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 967–971, June, 1911. Communication from the Inst. f. Radiumforschung.)—The authors have previously (1904) given the wave-lengths of two lines in the arc spectrum of Ra, the Ra-content of the material then used being only about 0·001 per cent. Tables are now given of the lines obtained with preparations containing respectively 0·1 per cent. and 70 per cent. Ra; 82 lines were observed with the former, and 50 lines with the latter of these, the wave-lengths ranging from 2709 to 6648. With the same preparations 10 spark lines were measured, between $\lambda = 2709$ and $\lambda = 4826{\cdot}1$. The spark lines are in good agreement with the measurements of Demarçay, Crookes [Abstract No. 2602 (1904)], and Runge

and Precht [Abstracts Nos. 2594 and 2605 (1904)]. A Rowland concave grating of 15 ft. focal length was used for the present measurements, which were made in the first order spectrum. A. W.

491. *Spectra of Iron and Titanium under Pressure.* **H. G. Gale** and **W. S. Adams.** (Astrophys. Journ. 35. pp. 10–47, Jan., 1912. Contribution from the Mt. Wilson Solar Observatory, No. 58.)—From a discussion of the arc spectrum of iron at a pressure of 9 atmos. and of the arc and spark spectra of titanium at pressures from a partial vacuum to 17 atmos. over a range of wave-length from λ3600 to λ6800 the authors give the following conclusion: (1) Reversed is a function of wave-length, being most frequent in the violet and less so towards longer wave-lengths. (2) With reduction of pressure below 1 atmo. the enhanced lines in the spectrum of Ti become relatively stronger. (3) The low-temperature lines of iron appear to form a distinct group, and have small displacements under pressure. (4) The other lines of iron may be divided into three groups for which the displacements bear the approximate ratios 1 : 2·3 : 4·5. If the flame lines are taken as a separate group the ratios are 1 : 1·5 : 3·4 : 6·6. (5) There appears to be some evidence in favour of a direct relation between pressure displacement and magnetic separation for iron when lines of the same group and of the same type of separation are considered. In the case of Ti no evidence of any connection with magnetic separation is found. (6) The values of the average displacement for the four iron groups at different wave-lengths are well represented by a law of variation of displacement with the third power of the wave-length. (7) The displacements of the Ti arc lines are found to be proportional to pressure for a range of 2–16 atmos. (8) The enhanced lines show much larger displacements than other lines of Ti. (9) The displacements of enhanced lines are greater in hydrogen than in air or CO_2 at the same pressure. (10) The Ti spark lines appear to be displaced more than the arc lines. C. P. B.

492. *Normal Wave-lengths of Iron Spectrum.* **P. Eversheim.** (Ann. d. Physik, 36. 5. pp. 1071–1076, Dec. 21, 1911.)—Previous papers have contained details of measurements of certain lines in the arc spectrum of iron which have been agreed on as serving for an International system of wave-lengths for spectroscopic reduction [Abstracts Nos. 242 (1908), 255 (1910)]. The present note gives a short description of the apparatus used in the interferential determination of the wave-lengths. A table is given showing the wave-lengths of the standard lines between λ4282·409 and λ3370·787, the values obtained by Fabry and Buisson being added for comparison. C. P. B.

493. *Spectrum of Magnesium High-frequency Arc.* **E. O'Connor.** (Phil. Mag. 23. pp. 94–101, Jan., 1912.)—The spectrum of an undamped oscillatory discharge between Mg electrodes was examined under various conditions. The generator employed was of the Poulsen type as previously used in an investigation of the Poulsen arc [Abstract No. 874 (1911)]. The oscillation frequencies of the currents used varied from 10^5 to $6·5 \times 10^5$ per sec., the current values ranging from 0·8 to 0·08 amp., at which latter value an arc could only just be maintained. Variation of the conditions of the oscillatory circuit produce marked variations of the spectrum. With a frequency of 10^5 per sec. the spectrum consists of a few lines on a continuous background, while at the higher frequency of $6·5 \times 10^5$ per sec. it becomes richer in lines, and the continuous spectrumh as disappeared to give place to a feeble band-

spectrum (nitrogen). The change in the appearance is gradual, not in the sense that the new spectrum continuously strengthens at the expense of the old one, but as the frequency is increased the spectrum tends to become unsteady, the continuous spectrum disappears and new lines come up intermittently; as the frequency is further increased the second spectrum predominates, and the first one comes up intermittently, finally disappearing as the frequency is further raised. Increased voltage with decreased current gives a further change of the spectrum. The nitrogen band spectrum is visible and the metal lines weakened even at the low frequency. With a high frequency and high voltage the spectrum consists of the band spectrum, the "*b*" triplet, and λ4481. That the current density is an important factor in the changes is suggested by the effect that the shape of the electrodes has on the spectrum. At low frequencies pointing the electrodes causes only an increase in the continuous spectrum, but at the higher frequencies it tends to accentuate the characteristic appearance of these spectra. Photographs of the spectra obtained under different conditions are reproduced and discussed. The work is being continued. A. W.

494. *Changes in Diffraction Spectra produced by Aberration, and Aberration of Echelon Grating.* **H. Stansfield** and **H. P. Walmsley.** (Phil. Mag. 23. pp. 25–35, Jan., 1912.)—Previous experiments with an echelon grating showed that a bright line in the mercury green line spectrum was accompanied by a series of faint fine lines on the longer-wave side [Abstract No. 1892 (1909)]. It was found that these lines were secondary maxima of the same wave-length as the bright line, for they moved farther away from the bright line when the number of apertures of the echelon was reduced. Rayleigh has shown that a cubic aberration of a continuous wave-front increases the first secondary maximum on one side of the image and decreases the one on the other side. Rayleigh's investigation has been extended to the first seven secondary maxima on either side of the primary, with special reference to the secondary maxima in diffraction spectra. It has been found that a cubic aberration amounting to ¼ of a wave-length at the edges of the aperture of the echelon employed is sufficient to explain why photographs taken with it show a series of secondary maxima on one side of a bright line and not on the other. The degree of aberration present in an echelon spectrum may readily be determined by measuring the distances of the brightened secondaries from the primary to which they belong. When the aberration in an echelon spectrum is relatively large the series of brightened secondary maxima provide a convenient scale of intensity which may be found useful in comparing the intensities of lines in the spectrum. Photographs have been taken (and reproductions are given) showing the effect of an aberration cell of ether vapour between a bent mica plate and plane glass plate on the secondary diffraction maxima of a wire grating. A. W.

495. *Pressure Shift of Spectral Lines.* **F. Sanford.** (Astrophys. Journ. 35. pp. 1–9, Jan., 1912.)—Discussing the various theories which have been proposed to account for the change of wave-length of spectrum lines due to pressure surrounding the light source, it is pointed out that they all make the change in the period of the vibrating mechanism depend upon the proximity of atoms of its own kind, since the greater the atmospheric pressure around the arc the denser must be the metallic vapour in the interior of the arc. A list is given of a number of elements, with their compressibility, melting-point, expansion coefficient, hardness, and pressure shift. There is a suggestive agreement in the variations of the different properties. Another table is given showing the relation between pressure shift, refraction constant, atomic volume, &c. The conclusion is that the pressure shift of the spectral lines is related to those properties of the atoms which seem to depend upon the specific inductive capacity. C. P. B.

496. *Energy Distribution in Spectra of Neon and Helium.* **W. W. Coblentz.** (Electrical World, 59. pp. 365–366, Feb. 17, 1912.)—The apparatus used consisted of a mirror spectrometer, fluorite prism, and vacuum bolometer, but the dispersion was not sufficient to enable individual lines to be located. Vacuum tubes containing Ne and He were investigated, with the following results. The spectrum of Ne consists of numerous fine lines, the most prominent group in the red not being resolved by the fluorite prism. The max. emission lies within this group of red lines, at about 0·64 μ. The intensity of the lines in the region 0·85 μ is only about $\frac{1}{10}$ that of the red. A slight emission was observed for 1·12 μ. Beyond this point no radiation was observed for the current (0·008 amp.) at which the tube was operated. The most intense line in the He spectrum lies at 1·083 μ. The intensity of a line at 2·05 μ is only 0·05, and the yellow line only 0·1 of that of the line at 1·083 μ. The luminous efficiency of the vacuum-tube radiation of air, nitrogen, CO_2, He, &c., is of the order of from 15 to 20 per cent., or perhaps lower, owing to the great amount of infra-red radiation emitted. In Ne the infra-red is almost entirely absent, so that its luminous efficiency is of the order of about 80 or 90 per cent. A. W.

497. *Spectrum of Boron.* **W. Crookes.** (Roy. Soc., Proc. Ser. A. 86. pp. 36–41, Dec. 22, 1911.)—Specimens of fused and of melted boron, prepared by Weintraub, were used, and the spark spectrum photographed, the exposures ranging from 1 to 2 hours. It is shown that the spectrum of boron consists of three lines, of wave-lengths 3451·50, 2497·83, and 2496·89. The 14 other lines given by Eder and Valenta, and the 5 other lines given by Exner and Haschek, failed to record themselves, notwithstanding the excessively long exposures. A. W.

498. *Positive Zeeman-effect and Theory of Ritz.* **A. Cotton.** (Le Radium, 8. pp. 449–456, Dec., 1911.)—Starting with the fundamental equations for the motion of a charged particle, it is shown how the theory of Ritz permits the prediction of the atomic motions for certain values of the defining constants. Various simple cases are examined with special reference to the positive Zeeman-effect. A consideration of Becquerel's results leads to the conclusion that we ought not to expect a common explanation for the magneto-optical properties of gases and crystals. Only the first of these are here dealt with. It appears that the theory of Ritz, without any modification, leads to cases of the positive Zeeman-effect if we assume a rotatory motion of the opposite sense to the intra-atomic currents of Ampère. A. W.

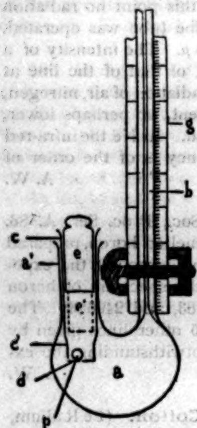
499. *Elliptic Interference with Reflecting Grating.* **C. Barus.** (Amer. Phil. Soc., Proc. 50. pp. 125–138, Jan.–April, 1911.)

500. *Diffraction of Light at a Plane Rectangular Corner of Infinite Conductivity.* **F. Reiche.** (Ann. d. Physik, 37. 1. pp. 131–156, Dec. 29, 1911.) —A highly analytical paper which reaches the conclusion that this corner acts like an ordinary edge. E. H. B.

HEAT.

501. *Thermal Conductivity of Graphite and Diamond.* **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 14. 1. p. 9, Jan. 15, 1912.)—The thermal conductivity of diamond is very high according to Eucken, nearly half that of silver. The author and J. Weiss [see Abstract No. 1894 (1911)] observed a still greater thermal conductivity ($\lambda = 0{\cdot}8$ at 30°) in a graphite crystal, which did not seem to be connected with the comparatively low electric conductivity. Crystalline silicon also conducts heat fairly well. These and other substances form exceptions to the law of Wiedemann-Franz. H. B.

502. *New Form of Dilatometer.* **F. Bottazzi** and **G. Buglia.** (Accad. Lincei, Atti, 20. pp. 623–627, Dec. 3, 1911.)—A new form of dilatometer is described, suitable for determining the change of volume occurring during solution, precipitation, hydrolysis, coagulation by heat or by enzymes, &c. In the Fig., *a* is a glass bulb, one end of which is drawn out to a capillary *b*, to which is attached a millimetre scale *g*, and at the other end is an opening with a ground surface, into which fits a cylindrical tube *c*, closed with a ground glass stopper *e*. At the base of the tube *c* is a disc of glass or ebonite *d* of the same diam as the extremity of the tube and perforated with a small hole in the centre, which is covered by a small glass marble *p*. This disc is attached to the tube by means of paraffin wax or solid fat, and serves to keep apart the contents of the bulb *a* and the tube *c*. By immersing the apparatus in a thermostat of water at a temperature sufficiently high to melt the wax or fat, the disc becomes detached and the two liquids mix, when the volume-change can be noted on the scale *g*. W. H. St.



503. *Very High Temperatures.* **J. A. Harker.** (Engineering, 93. pp. 225–226, Feb. 16, 1912. Abstract of discourse delivered before the Royal Inst., Feb. 9, 1912. Electrician, 68. pp. 964–965, March 22, 1912. Extract.)—A general lecture on high-temperature researches with special reference to the author's work at the National Physical Laboratory with the aid of tubular and other furnaces, spiral carbon resistances, and tubes made of the rare earths, directly or indirectly heated. When placed within carbon tubes, these tubes of refractory materials became carburised and crumbly on the outside, suggesting that electrified particles were shot off from the hot carbon at ordinary pressure; ionisation currents of up to 10 amps. were observed at 2000° C. between hot carbons. Investigating these phenomena together with G. W. C. Kaye and C. C. Eden, the author obtained a new kind of thermo-currents by heating a carbon tube (not joined to any source of electricity) within a furnace and letting a carbon rod travel in and out of the tube (or a cooled jacket); the cooler carbon was positive to the hotter. At 2500° C. currents of 2 amps. were obtained. H. B.

504. *Specific Heat of Air at Room Temperatures and at Low Temperatures.* **K. Scheel** and **W. Heuse.** (Ann. d. Physik, 87. 1. pp. 79–95, Dec. 29, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—The principle of the method used by the authors is as follows: Through a tube, which is immersed in a thermostat, and acts as the calorimeter proper, a current of air is passed at a constant rate. In the middle of the tube the air is warmed by passing over an electrically heated wire, the temperature of the air being taken as it enters the calorimeter and just before it leaves it by means of carefully calibrated Pt-resistance thermometers. If, when a steady state is reached, the quantity of air flowing through the tube per sec. is Q, the quantity of heat put into the air is Λ, and the rise in temperature is Δt, the specific heat is $c_p = (\Lambda - \lambda)/(Q\Delta t)$, where λ is the correction for radiation losses. In the apparatus used by the authors, which is fully described, the radiation losses are reduced to a few tenths of one per cent. Empirically, the experimental results at room temperature are given by the formula $\Lambda/(Q\Delta t) = c_p + k_1/Q + k_2/Q^2$, where c_p is the true specific heat for $Q = \infty$, and k_1 and k_2 have the values $-0{\cdot}000076$ and $+0{\cdot}0000452$ respectively; c_p is then found to be 1·0085. Theoretically, the equation $c_p = \Lambda(1 - k/Q^2)/(Q\Delta t)$ can be deduced, and for the experiments at room temperature c_p is found to be $1{\cdot}008_6$, in agreement with the result worked out from the empirical equation, whilst k has the value $0{\cdot}000040_1$. The final results for the specific heat of dry CO_2-free air at atmospheric pressure are as follows:—

Temperature	$+20°$	$-78°$	$-183°$
c_p in watt-sec. per gm. degree	1·009	1·019	1·058
c_p in gm.-cals.$_{15}$/(gm. degree)	$0{\cdot}240_8$	$0{\cdot}243_3$	$0{\cdot}252_5$

The value at 20° is in very good agreement with the value obtained by Swann [Abstract No. 1280 (1910)], namely, 1·010 watt-sec. per gm. degree, and shows that it is much greater than former observers, especially Regnault, have found it to be. Moreover, the results prove definitely that the specific heat of air increases with decrease in temperature. T. S. P.

505. *Specific Heat of Gases.* II. **N. Bjerrum.** (Zeitschr. Elektrochem. 18. pp. 101–104, Feb. 1, 1912.)—The former calculations [see Abstract No. 1518 (1911)] were partly based upon Pier's determinations of the specific heats of gases by the explosion method. The author finds that in these determinations some heat was lost, and that the max. pressures should therefore be about 1·8 per cent. higher than he had previously assumed. That would make little difference for the specific heats of argon, nitrogen, hydrogen, but would lower the specific heat of water-vapour by about 5 per cent. The rise of the specific heat of water-vapour in the interval, in which dissociation takes place, would appear to resemble the rise in the specific heats of solids when their melting-points are approached. H. B.

506. *A Simple Relationship between Coefficient of Expansion of a Liquid and its Temperature.* **M. Oswald.** (Comptes Rendus, 154. pp. 61–63, Jan. 8, 1912.)—From the law of rectilinear diameter it follows that the densities D and d of a liquid and its vapour are given by the formula $D + d = A - BT$, and if D_0 = the density at 0° A., D_c = the density of liquid of vapour at the critical temperature, $D + d = D_0 - (D_0 - 2D_c)T/T_c$. For liquids of small vapour density d may be neglected and $D = D_0(1 - T/2T_c)$, whence $a = 1/(2T_c - T)$. This formula can be tested by using it to calculate the critical temperature. In the case of 15 non-polymerised liquids the average of the calculated to the observed value is 2 : 1·967, the individual ratios varying from 1·82 to 2·05. Polymerised liquids show greater deviations. T. M. L.

507. *Measurements of Specific Heats at Low Temperatures.* **A. S. Russell.** (Phys. Zeitschr. 13. pp. 59–64, Jan. 15, 1912.)—The author has determined the specific heats of a number of compounds over different ranges of temperature. In addition to those mentioned below the substances investigated comprised CuO, PbO, HgO, Fe_2O_3, Cr_2O_3, As_4O_6, Sc_2O_3, CeO_2, ThO_2, PbO_2, MnO_2, U_3O_8, WO_3, HgS, CuS, Sb_2S_3, CdS, TlCl :—

Substance.	Mean Temp. Abs.	Mean Spec. Heat.	Atomic or Molecular Heat.	Mean Atomic Heat.
MgO	183	0·1006	4·06	2·03
	234	0·1938	7·80	3·90
	298	0·2385	9·62	4·81
Al_2O_3	187	0·0789	8·06	1·61
	234	0·1560	15·94	3·19
	299	0·2008	20·47	4·09
Thallium	187	0·0288	5·87	5·87
	236	0·0304	6·20	6·20
Si (cryst.)	183	0·0861	2·44	2·44
	234	0·1447	4·10	4·10
	297	0·1712	4·84	4·84
Si (amorph.)	183	0·0918	2·58	2·58
	234	0·1504	4·26	4·26
	300	0·1796	5·08	5·08
Mercury	252	0·0335	6·70	6·70
NaCl	297	0·2078	12·14	6·07
KCl	296	0·1661	12·39	6·19
SiC	183	0·0513	2·07	1·03
	235	0·1195	4·82	2·41
	298	0·1620	6·53	3·27

The above determinations were carried out for the purpose chiefly of ascertaining whether Kopp's law of additivity of atomic heats is valid, or, in the more modern language, whether the proper frequency of the elements remains unchanged in compounds. The author finds that it does not remain unchanged. It is also of interest that the *molecular heat* of silicon carbide at 183° abs. is considerably smaller than the *atomic heat* of silicon. A. F.

508. *Relations between Critical Temperatures, Boiling-points, and Expansion Coefficients of Liquids. Formula of Avenarius.* **P. A. Guye.** (Faraday Soc., Trans. 7. pp. 119–121, Nov., 1911.)—In reference to a paper by Prideaux [Abstract No. 1300 (1911)], the author points out that the formulæ of Mendelejeff and of Thorpe and Rücker are only approximations, and that their application may lead to discrepancies which will much exceed the errors of observation. By the substitution of the absolute boiling-point, T_s, for the absolute critical temperature T_c, in the formula of Thorpe and Rücker, the relation $V_1/V_2 = D_2/D_1 = (a'T_s - T_2)/(a'T_s - T_1)$ is deduced, in which a' is a constant having the value 3·09; this relation gives good results for the dilatation of liquids over a large temperature interval. The formula of Avenarius, namely, $\log V = c - d \log (A - t)$, contains only three constants and gives a more exact relation between the volume and temperature. The constants may be found by the method given by Mallet and Friderich [Abstract No. 69 (1908)], and good results are obtained for temperature intervals of from 150–180°. The formula permits of determining for each temperature the value $dv/dt = (d \log e)/(A - t)$, and consequently also the dilatation coefficient $(1/v)(dv/dt)$ at any temperature. The observed and calculated values of dv/dt are in remarkable concordance. The constant A is very nearly the observed critical temperature, exceeding it by 5° or 10°; c represents the critical density, and $c/d = 8·78$. T. S. P.

509. *Further Experiments with Liquid Helium. Isotherms of Monatomic Gases, &c. IX. Thermal Properties of Helium.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 678–684, Jan. 24, 1912. Communication No. 124*b* from the Phys. Lab., Leiden.)—The author has carried out further more exact determinations of the vapour pressure of helium. The following values were found :—

Temperature.	Vapour Pressure. Mm. Mercury.
4·28° K.	767
4·97°	1329
5·10°	1520
5·15°	1569
5·22°	1668
5·25° (crit.)	1718 (crit.)

The critical temperature may be taken as 5·25° K. and the critical pressure as 2·26 atmos. The authors have also recalculated the value of f_w in the van der Waals vapour-pressure formula (with common logarithms) and find, at the boiling-point, the value 1·8; above the boiling-point it is found that f_w increases rapidly in value and becomes at the critical point 1·95, a number smaller than for any other substance. From the observed values of the densities of coexisting liquid and saturated vapour, the critical volume is calculated to 0·00271. In contradiction with what the author formerly deduced, the new data confirm, at least approximately, van der Waals' expectation that the relation he deduced between the critical constants should be found to hold for He also. The critical virial quotient $RT_c/p_cv_c = K_4$ thus becomes 3·18 (for argon it is 3·283). The author therefore considers that the apparent association at the critical temperature is, in the case of He, still subject to practically the same laws as hold for ordinary normal substances. The great difference between He and normal substances makes itself apparent at lower reduced temperatures, as shown by the marked diminution in the value of f_w at lower reduced temperatures, at which also the liquid density attains a maximum. This difference can well be the result of an influence of proximity to the absolute zero at very low temperatures, quite different from that which obtains ordinarily for the same values of the reduced temperature, due to the fact that the liquid state lies much closer to the absolute zero with helium than with any other substance. A. F.

510. *Rate of Decay of different Sizes of Nuclei.* **C. Barus.** (Amer. Journ. Sci. 33. pp. 107–108, Feb., 1912. Abstract from Report to Carnegie Inst. of Washington.)—The author has investigated the drops produced with various expansions in a fog chamber after a short exposure to X-rays. The rates of decay of the nuclei were estimated from the apertures of the corresponding coronas. The results show that the large ions or nuclei produced by X-rays in dust-free wet air vanish with relatively enormous rapidity, whereas the very small nuclei are almost indefinitely persistent, and there is a definite relation between the rate of decay and the size of the nucleus. If, therefore, these nuclei are regarded as water droplets of different sizes, evaporation is rapid until a limiting diam. depending on the intensity of radiation is reached, after which evaporation nearly ceases. It is also probable that the limiting diam. increases with the intensity of radiation, so that with strong X-rays almost no supersaturation is required. E. M.

511. *Solid Oxygen by Evaporation of the Liquid.* **J. Dewar.** (Roy. Soc., Proc. Ser. A. 85. pp. 589–597, Nov. 30, 1911.)—The solidification of oxygen is more difficult to effect than that of hydrogen and nitrogen, because oxygen has a small vapour pressure at its melting-point. With the aid of coconut charcoal (75 gm.) up to 10 cm.^{3} of liquid oxygen have been transformed into a transparent jelly within a silvered vacuum-jacketed tube placed inside a similar wider tube filled with liquid air. The pressure at which solidification takes place, determined with the aid of a McLeod gauge, is 1·12 mm.; the melting-point would then, by extrapolation from Willard Gibbs's vapour tension formula, be 53·8° K. The subsequent determination by means of a hydrogen thermometer yielded 54° K., while Kamerlingh Onnes finds 54·6°. J. W. Heath and W. Green assisted in the experiments. H. B.

512. *Inflammation of Mixtures of Paraffin Hydrocarbons and Air; Lower Limit.* **M. J. Burgess** and **R. V. Wheeler.** (Chem. Soc., Journ. 99. pp. 2013–2030, Nov., 1911.)—The smallest quantity of combustible gas which, when mixed with a given quantity of air (or oxygen), will enable self-propagation of the flame to take place, is termed the lower limit of inflammation. The experiments were made in a glass sphere of 2 litres' capacity with two stout axial Pt-wires in glass tubes, ending in free knobs 8 mm. in diam., as electrodes. The lower limits found are: methane, 5·50 to 5·70 per cent. in agreement with Mallard and le Chatelier (Teclu found about 3·5 per cent.); ethane, 3·00 to 3·20 per cent.; propane, 2·15 to 2·30 per cent.; *n*-butane, 1·60 to 1·70 per cent.; *n*-pentane, 1·35 to 1·40 per cent.; iso-pentane, 1·30 to 1·35 per cent. The length of the spark-gap (10 to 50 mm.) made little difference; but a flaming Wehnelt spark of 30 mm. caused explosion, where the induction coil spark merely produced rapid burning. Small variations in temperature and pressure, such as might occur in coal-mines, did not affect the results. H. B.

513. *Vapour Tensions of Nitrogen Tetroxide.* **F. E. C. Scheffer** and **J. P. Treub.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 536–549, Dec. 28, 1911.)—In the case of the vaporisation of a substance which dissociates in the vapour phase, two factors come into play: the evaporation process itself, and the velocity with which equilibrium is established in the vapour phase. If the first velocity is small with respect to the second, stable equilibrium will exist at any moment between the solid substance and the vapour surrounding it, and the same values will be found according to the statical or dynamical method of determination. If, however, the first velocity is great with regard to the second, the solid substance will be surrounded by a vapour which is little dissociated, at least less than is the case for the stable coexistence. Hence the dynamically determined Pt-line, the position of which depends on the rapidity of heating, will be at higher temperatures or at lower pressures than the statical one. As the values for the vapour pressures of nitrogen tetroxide as determined by Ramsay and Young, and by Guye and Drouginine, dynamically and statically respectively differ appreciably, the authors have redetermined the vapour pressures by a statical method, and have obtained results in harmony with those of Ramsay and Young. The following are the values found :—

Equilibrium Solid-gas.		Equilibrium Liquid-gas.			
t.	*p.* (mm. of Mercury).	*t.*	*p.*	*t.*	*p.*
−36°	18	−23	70	11·0	463
−28	34	−20	85	12·4	497
−23	53	−18	96	15·0	565
−20	70	−15	115	16·5	608
−14	114	−13	128	19·2	690
−10·8	146	−10·8	146	21·45	770
		− 6·9	180	24·8	878
		− 5·8	198	27·4	1007
		− 2·6	227	29·55	1108
		− 0·6	256	32·55	1268
		+ 0·8	276	35·65	1447
		4·1	328	39·0	1668
		7·7	398	41·15	1825
				43·2	1982
				45·65	2189
				47·2	2329
				48·7	2478

A. F.

514. *Radiating Power of Air.* **E. Gold.** (Nature, 88. p. 448, Feb. 1, 1912.)—The radiating power is the rate at which air is losing heat by radiation to surroundings 1° C. colder. Values for the radiating power have been deduced both from observations of air temperature at night and from experiments in the laboratory. It is shown that the formulæ by which values of the radiating power are obtained from the observations in the two cases do not give measures for the same physical quantity, but that the formula used for the meteorological observations should give values for the radiating power twice as large as those derived from the formula used in the case of laboratory experiments. R. C.

515. *Thermodynamics and Specific Heat.* **W. Nernst.** (Preuss. Akad. Wiss. Berlin, Ber. 6. pp. 134–140, 1912.)—Taking, as the starting-point, the experimental fact that the specific heat of solid substances converges to the value zero at low temperatures, the author shows that his heat theorem can be formulated as follows : It is not possible to cool a body to the absolute zero by means of a process taking place with infinite dimensions.—At the same time a stringent experimental foundation for the heat theorem is

obtained, as also conceptions by means of which it may be extended, and applied, for example, to the Peltier-effect. [See Abstract No. 1702 (1911).]
T. S. P.

516. *Planck's Working Quantum.* **G. E. Gibson.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 104–112, Jan. 30, 1912.)—Remarks upon the working quantum of Planck, with an examination of the derivation of the theory. The present author finds that the quantity γ given by $\gamma = h^2/\pi^2 e^2 m = 7{\cdot}47 \times 10^{-9}$ cm., is a universal constant, namely, the radius of a resonator whose small positive sphere has the charge e.
E. H. B.

517. *Molecular Heat of Hydrogen at Low Temperatures.* **A. Eucken.** (Preuss. Akad. Wiss. Berlin, Ber. 6. pp. 141–151, 1912.)—Using an apparatus similar in principle to that described by Nernst for the determination of the specific heat of solid substances [Abstracts Nos. 822 (1910), and 1702 (1911)] the author has determined the molecular heat of hydrogen between the temperatures 35° and 273° abs. The molecular heat, reduced to the value it would have if hydrogen were an ideal gas, at first decreases rapidly with fall in temperature, attaining, however, a constant value of 3 cals. for temperatures below 60° abs.; this constant value is the same as the molecular heat of monatomic gases. The influence of the density on the value of the molecular heat (C_v) is greater at low than at higher temperatures, over the temperature range of approximately 60–90 deg. abs. The variation of C_v, with the alteration in density, is in agreement with that calculated from D. Berthelot's equation of condition. The course of the curve showing the relation between C_v and the temperature is in qualitative agreement only with the theories which have been hitherto proposed. By means of a provisional theory which takes into account the elastic force between the atoms a good agreement is obtained. It is supposed that only at very low temperatures is the force strictly elastic; with rise in temperature it increases at a greater rate than the distance apart of the atoms, becoming infinitely great when the atomic distance attains its limiting value. [See also Abstracts Nos. 900 and 1707 (1911).]
T. S. P.

518. *Approximate Equation of Condition.* **L. Pochhammer.** (Ann. d. Physik, 37. 1. pp. 103–130, Dec. 29, 1911.)—The author modifies van der Waals' equation, $p = RT/(v - b) - a/v^2$, as follows, retaining the fundamental idea that it must be an equation of the third degree with respect to the volume. At high pressures it is probable that the translational energy of the molecules will diminish in comparison with the molecular vibrations, and this may be allowed for by multiplying the first term by the factor $1/(1 + Bp)$, where B is a positive constant. The introduction of this factor makes the critical constants, T_k, p_k, v_k, independent of each other, so that the quotient $RT_k/v_k p_k$ can assume any value. The second term of van der Waals' equation is altered by replacing v^2 by $(v + A)^2$, where A is a constant, in order to express the idea that when the molecules are very close together at high pressures, there are repulsive as well as attractive forces between them: a molecule in the limiting layer is repulsed by the molecules in the immediate neighbourhood, whilst it is attracted by the remaining molecules within the sphere of action. Also a is replaced by the function kH, which decreases with increasing pressure, and has the value $k(H = 1)$ at the critical point. The altered equation of condition then becomes $p = RT/(v - b)(1 + Bp) - kH/(v + A)^2$. The author tests this equation on the existing experimental data for ethyl

ether, ethyl alcohol, *iso*pentane, and pentane, and finds a very good agreement between theory and experiment. He is also able to deduce from it the rule of Cailletet and Mathias that the mean of the densities of the liquid and saturated vapour is a linear function of the temperature. T. S. P.

519. *Pressure of Saturated Vapours.* **F. Ollive.** (Comptes Rendus, 154. pp. 188–190, Jan. 22, 1912.)—The author is led by theoretical considerations to believe that the pressure of a saturated vapour will follow a geometrical progression when the corresponding temperatures follow an arithmetic progression. For steam between 0° and 100° C. a table is calculated which agrees very closely with experiment. The equation used is $\Delta p = aq^{t-1}$, where t = mean temperature in the interval of pressure Δp and a and q are constants which are different for different ranges of temperature. Between 70° and 100° C. $a = 10{\cdot}5$ mm. of mercury, and $q = 1{\cdot}033$. Δp denotes the increment of pressure per 1 deg. C. H. S. R.

520. *Black Radiation.* **M. Planck.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 113–118, Jan. 30, 1912.)—Discusses the foundation of the law of black radiation expressing the distribution of energy in the spectrum of a black body, the existence of linear oscillators of definite period being postulated. Taking for e/m Bestelmeyer's most recent value $1{\cdot}77 \times 10^7 \times c$, where $c = 3 \times 10^{10}$, and putting $e = 4{\cdot}69 \times 10^{-10}$, $k = 1{\cdot}35 \times 10^{-16}$, $h = 6{\cdot}55 \times 10^{-27}$, the author deduces the following:—

Mean frequency of undisturbed vibrations $\lambda = 1{\cdot}87 \times 10^7 \times \lambda \times e^{14600/\lambda T}$, λ being in cm.

Emission number per sec. $= \dfrac{2{\cdot}18 \times 10^7}{\lambda^3} Ne^{-14600/\lambda T}$.

Mean accumulation time $= 4{\cdot}58 \times 10^{-6} \times \lambda^2 \times e^{14600/\lambda T}$. E. H. B.

521. *Entropy and Probability.* **L. S. Ornstein.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 840–853, March 28, 1912.)—Mathematical.

522. *The Problem of Partition of Energy, especially in Radiation.* **W. Peddie.** (Phil. Mag. 22. pp. 663–668, Oct., 1911.)—Mathematical.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

523. *Mechanical Model of an Electron.* **U. Cisotti.** (N. Cimento, 2. Ser. 6. pp. 375–386, Nov., 1911.)—Beside the rigid electron of Abraham, and the deformable electrons of Lorentz, Bucherer, and Langevin, the author considers an elastic sphere moving in an infinite liquid and deformed by the pressure of the liquid on its surface. The sphere will become an ellipsoid with its minor axis in the direction of motion. The shortening of the minor axis and the lengthening of the equatorial axis are both proportional to the square of the velocity, and so is the increase of volume produced. E. E. F.

524. *Electricity and Matter.* **D. F. Comstock.** (Amer. Phil. Soc., Proc. 50. pp. 321–332, July–Aug., 1911.)—A lucid *résumé* of the present state of science as to the *mass* associated with electric charges and radiation and *proportional* to the *energy* concerned in such case. The address concludes with an allusion to the principle of relativity as a modern group of conceptions teaching that the idea of absolute motion is entirely superfluous, and that the time-honoured concepts of space and time, as independent of all motions, do not accurately fit the real universe and should be modified. [See Abstract No. 384 (1910).] E. H. B.

525. *Electromagnetic Impulse Equations on the Relativity Theory.* **J. Ishiwara.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 2. pp. 164–176, Dec., 1911.)—The vector analysis here used has reference to Minkowski's four-dimensional space, in which the following quantities are to be distinguished:—(1) The *scalar* A; (2) the vector of the *first* kind or the *four-vector* P with its four components P_1, P_2, P_3, and P_4; (3) the vector of the *second* kind or the *six-vector* F with its six components, F_{23}, F_{31}, F_{12}, F_{14}, F_{24}, and F_{34}; (4) the *tensor* T with 16 components. The scalar and vector products of these quantities and their ordinary and partial differential coefficients are dealt with. Then follow the fundamental electrodynamical equations of moving bodies, the principle of virtual displacements, the theorem of moments, and, finally, remarks on the theories of Abraham and of Minkowski. [See Abstracts Nos. 1215 (1910); 446, 1086 (1911).] *Errata* (Ibid. p. 201, Feb., 1912.) E. H. B.

526. *Groups of Electrons in a Sphere of Positive Electricity.* **A. E. Haas.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1111–1171, July, 1911.)—In Thomson's electronic model of the atom it is a necessary condition of equilibrium that the central attraction on any electron shall be equal to the resultant repulsions of the other electrons, and shall also be in the same direction. This condition is not fulfilled in, say, an outer ring of 11, and an inner ring of 7 electrons, and one electron at the centre of the sphere of positive electricity. The present work is a mathematical search for stable groups fulfilling the above condition of equilibrium. The types considered comprise similar and concentric regular polygons, double pyramids, prisms, and concentric regular polyhedra. An interesting result concerns the max. number of electrons capable of forming a ring in equilibrium (not necessarily stable). It turns

out to be 471 (as against Thomson's maximum of 5 for stable equilibrium). This number is just double the atomic weight of uranium. Another result is when there is equilibrium in a state of rest, and rotation supervenes, the new configuration of equilibrium is geometrically similar but all the linear dimensions are increased in the same ratio. E. E. F.

527. *Charge Determinations by Silver Nuclei.* **E. Weiss.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1021-1068, July, 1911.)—An elaborate research following up the methods used by Ehrenhaft and by Millikan, the final mean value of all the determinations being $e = 4{\cdot}45 \times 10^{-10}$. Twenty sets, each of 10 or more separate measurements, gave $e = 4{\cdot}88 \times 10^{-10}$. [See also Abstracts Nos. 282, 508, 586, 686 (1911).] E. H. B.

528. *Electrostriction.* **E. P. Adams.** (Phil. Mag. 22. pp. 889-900, Dec., 1911.)—The object of this paper is the mathematical development of formulæ for some important cases of electrostriction, particularly those involving cylindrical condensers. The cases considered are: (1) The elongation of a cylindrical condenser with adherent armatures, in which the result is reached that the elongation of a charged cylindrical condenser is due wholly to the changes in the dielectric constant resulting from the strain in the dielectric; (2) a cylindrical condenser with non-adherent armatures; (3) the increase in internal volume of a charged spherical condenser; (4) Wüllner and Wien's experiments in which measurement was made of the increase in internal volume of a cylindrical condenser whose ends were closed by hemispherical condensers of the same internal radius and thickness of dielectric. J. J. S.

529. *Convection Currents.* **L. de la Rive.** (Archives des Sciences, 33. pp. 28-31, Jan., 1912.)—Obtains the relation between a current element, *ids*, as used in Laplace's law, and the form, *vdq*, which is more convenient when a charge *dq* is regarded as moving with speed *v*. The relation in question is that of equality, or $vdq = ids$. [See Abstract No. 1246 (1911).]

E. H. B.

530. *Mutual Attractions or Repulsions of Two Electrified Spherical Conductors.* **A. Russell.** (Inst. Elect. Engin., Journ. 48. pp. 257-268, Feb., 1912.)—In this paper tables and formulæ are given by means of which the capacity between two equal spheres and the component capacity of each of them, whatever their distance apart, can be found at once. Hence the charging currents to spherical electrodes can also be readily found. Very simple formulæ are also given which enable the rates of variation of the capacity coefficients to be accurately computed when the distance between the spheres is not less than the radius of either. We can thus, with the help of other formulæ previously published by the author, determine the numerical values of the attractions and repulsions between equal spherical conductors either when their charges or when their potentials are given. Tables are appended illustrating the magnitude of the errors introduced into Coulomb's law for the attraction or repulsion of small electrified conductors by the neglect of the magnitude of these conductors. A. R.

531. *Capacity and Dissipated Energy in Dielectrics.* **L. Décombe.** (Comptes Rendus, 153. pp. 1469-1472, Dec. 26, 1911, and 154. pp. 191-193, Jan. 22, 1912.)—If an unpolarised dielectric plate is placed in an electric field $E = f_1(t)$ and, after a definite interval, the field is suddenly increased by the amount $E' = f_2(t)$, the polarisation m at any subsequent time is the resultant obtained by superposing the polarisation m_1 due to the first field on the polarisation m_2 due to the second. The polarisation current is at any instant proportional to the excess of the field E over the fictitious field bm due to polarisation. From the electronic point of view polarisation must be considered as determined by the deformation of the atom, and the polarisation current as proportional to the rate of deformation. It follows that residual and allied phenomena such as the dissipated heat (Siemens) are negligible unless the atom is deformed with a finite velocity. This suggests that the Siemens heat, or, generally, the uncompensated heat disengaged in any physico-chemical process, is due to a viscosity of the atom. E. E. F.

532. *Atmospheric Electricity Observations on the Second Cruise of the "Carnegie," from New York to Colombo.* **E. Kidson.** (Terrestrial Magnetism, 16. pp. 237–242, Dec., 1911.)—The paper is in three parts and deals with (1) the specific conductivity of the atmosphere, (2) the radio-activity observations and (3) the measurements of potential gradient. The method of observation in (1) and (2) was similar to that adopted on the previous cruise [see Abstract No. 1307 (1910)]. For the measurements of potential gradient a radium collector was used attached to the end of a pole projecting 3·6 m. from the stern of the ship. As no standardisation tests were made on the apparatus the values given are only relative and cannot be translated into absolute values of potential gradient in an undisturbed field. The results obtained are set out in three tables. The general conclusions reached are that there appears to be a diminution in the conductivity in equatorial regions and, at any rate during the daytime, in the near neighbourhood of land. At the same time the ratio of the conductivity for positive electricity to that for negative becomes smaller. As was to be expected, a low potential gradient was in general associated with a high conductivity, and *vice versâ.* The potentials observed were always positive. J. S. Di.

533. *Aggregates of Electrons.* **O. W. Richardson.** (Amer. Phil. Soc., Proc. 50. pp. 347–365, July–Aug., 1911.)—An account of the present state of knowledge as to electrons and matter, radiation and material media, and the number of electrons in the atom. E. H. B.

534. *Uniform Motion on Electrical Theory of Matter.* **W. F. G. Swann.** (Phil. Mag. 23. pp. 64–86, Jan., 1912.)—The Lorentz shrinkage and the conception of local time have usually been derived from the fact that the electromagnetic equations, when transformed to a system of moving axes, reverted to the type for a system at rest. The present paper deduces the contraction and its associated results by a less abstract method of reasoning and without the transformation. E. H. B.

535. *Electronic Motions and the Lorentz Contraction.* **W. F. G. Swann.** (Phil. Mag. 23. pp. 86–94, Jan., 1912.)—Discusses the determination of the motions of electrons when considered as singularities, moving so as to satisfy the electromagnetic scheme. E. H. B.

536. *Rotating Electric Field Phenomena.* **A. Lampa.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1007–1018, June, 1911.)—A mathematical discussion of the theory of the above in a simple case of alternating electric fields. [See Abstract No. 101 (1907)]. E. H. B.

537. *Induced Currents in a Network on the Principle of Least Action.* **J. Loif.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 128–136, Jan. 30, 1912.)—A mathematical paper unsuitable for detailed abstraction. [See Abstract No. 361 (1912)]. E. H. B.

538. *Motion of Charged Spheres.* **G. H. Livens.** (Phil. Mag. 22. pp. 943–948, Dec., 1911.)—Deals with the vibration of a charged conducting sphere and the slow rotation of charged spheres of dielectric material. E. H. B.

DISCHARGE AND OSCILLATIONS.

539. *Conductivity of a Gas between Parallel Plate Electrodes.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 86. pp. 72–77, Dec. 22, 1911.)—The relation connecting the current with the p.d. between parallel plate electrodes when the gas between the plates has been uniformly ionised by Röntgen rays or Becquerel rays has been investigated by many workers. [Mie, Abstract No. 1745 (1904); J. J. Thomson, "Conduction of Electricity through Gases," p. 84]. In all cases various assumptions are made in order to simplify the calculations, as the problem becomes very complicated when the disturbance in the field due to the separation of the ions is taken into consideration. The present paper deals with a calculation of the degree of saturation corresponding to a given e.m.f. sufficiently large for the current to be within only a few per cent. of its max. value. The variations in the field between the electrodes in these circumstances are also calculated. E. M.

540. *Electric Carbon Deposits in Flames.* **B. Thieme.** (Zeitschr. Phys. Chem. 78. pp. 490–498, Jan. 8, 1912. Zeitschr. Elektrochem. 18. p. 131, Feb. 15, 1912.)—When two wire electrodes (copper) are held in a candle or burner flame, the one above the other, about 1 cm. apart, soot is deposited on the kathode in a trunk growth from which threads branch off, provided the potential (battery) exceeds 12 volts; raising the potential above 25 volts serves no object. With spark discharges from an influence machine the positive pole need not be within the flame. When the current is reversed the carbon deposit separates in flakes from the electrode. With sparks from an induction apparatus the deposit may appear at the anode. The deposited soot is very fine and soft, and the process might technically be utilised. The author proposes an apparatus for this object, comprising a long flame (from holes in a horizontal tube) and a relay which breaks the current and shakes the carbon off, as soon as the carbon threads bridge over to the other electrodes. When solid salts (copper sulphate, mercury nitrate, sodium chloride, &c.) are introduced into the flame in beads supported by a Pt-wire between zinc-plate electrodes or iron wires, some metal is deposited on the kathode, sometimes also on the anode or on the Pt by the spark discharge. In the case of sodium or potassium the intense colour of the flame is taken as indication of a reduction. The experiments are being continued. H. B.

541. *Positive Ionisation produced by Phosphates when heated.* **F. Horton.** (Cambridge Phil. Soc., Proc. 16. pp. 318–320, Dec., 1911.)—In view of the results previously obtained by the author [see Abstract No. 650 (1911)], and more especially the earlier ones of J. J. Thomson, the conclusion of W. Wilson that the positive leak when aluminium phosphate is heated upon Pt is mainly due to the Pt is disputed. Observations have now been made of the positive leak from lithium phosphate in air, in oxygen, in CO, and in hydrogen at pressures between 0 and 80 mm. under a saturation voltage. The observations in each case are made with phosphate at 800° C. It is found that the positive ionisation produced by lithium phosphate in air is of about the same magnitude as that from sodium phosphate under similar conditions. The effect of substituting other gases for air is of a similar nature to that with sodium phosphate. The leak in oxygen is about the same as that in air; CO increases the leak considerably, and there is a still further increase with hydrogen. Starting with any gas at high pressure and gradually reducing this, the positive leak increases slowly at first, then more rapidly, until at a pressure usually between 0·1 and 0·3 mm. a maximum leak occurs, after which the leak falls off very rapidly as the pressure is still further reduced. In experiments with sodium phosphate the pressure of maximum leak is higher than with lithium phosphate. It seems as if the former attains equilibrium with the surrounding gas more quickly than the latter. Evidence with lithium phosphate of a pressure of maximum leak in hydrogen, as well as in the other gases named, is now obtained. A. E. G.

542. *Ionisation produced by Carbon at High Temperatures.* **J. N. Pring** and **A. Parker.** (Phil. Mag. 23. pp. 192–200, Jan., 1912.)—It is well known that there is a leak of negative electricity from strongly heated carbon. Various experimenters have concluded that this is connected with the temperature of the carbon by the Richardson formula $I = A\theta^{\frac{1}{2}}e^{-b/\theta}$, where I denotes the ionisation current, A and *b* are constants, and θ is the absolute temperature. The present paper deals with observations up to very high temperatures with special attention to the accuracy of the temperature readings, the purity of the carbon, and the pressure of the surrounding gas. The carbon rod used was purified by heating to 2000° for a long interval at a very low pressure. In the experiments this rod was heated by an electric current and the temperature readings taken by an optical pyrometer. The emission of negative electricity was measured by establishing a field of 200 volts between the heated carbon rod and a carbon electrode. The following are the results of experiments between 1300° and 2050° abs.: (1) The negative ionisation from heated carbon falls continuously, both with reduction of the pressure and with progressive purification of the carbon. (2) At 2000° the lowest value found was 4×10^{-7} amp., while Richardson's formula gives, at this temperature, about 100,000 amps. (3) Above 1800° the ionisation only increases very slightly with the temperature. Thus the results do not agree with Richardson's formula, and show that the large currents hitherto obtained with heated carbon cannot be ascribed to the emission of electrons from carbon itself, but they are probably due to some reaction at high temperatures between the carbon or contained impurities and the surrounding gases. E. M.

543. *Nature and Velocity of an Ion in a Gas.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 16. pp. 285–298, Dec., 1911.)—It has usually been assumed in investigations on the nature and motion of an ion in a gas that its nature varies with the temperature but is constant at constant temperature. But it follows from thermodynamical and other considerations that the nature of an ion must be continually changing at constant temperature. The formation and breaking-up of a cluster is governed by the same laws as those which govern the formation and dissociation of a molecule in a gas, the only difference is that in one case the cluster of atoms is held together by chemical attraction, and in the other by chemical and electrical attraction. It follows that the formulæ deduced for the velocity of an ion in a gas on the supposition that it is stable do not represent the facts, and the present paper deals with an investigation of the average velocity and other properties of an ion whose nature is continually changing. The author shows, among other deductions, that the effect of the changing nature of the ion becomes appreciable at low pressures, and will make the velocity apparently increase with decrease of pressure, since the velocity of the quickest-moving ions is generally measured in experiments. E. M.

544. *Mobility of Ions in Air at High Pressures.* **A. J. Dempster.** (Phys. Rev. 34. pp. 53–57, Jan., 1912.)—The determination of the mobilities of ions in air at much higher pressures than have hitherto been used may afford evidence on which to base theoretical considerations of the mobility of ions in gases. It is with this idea in view that the present experiments were undertaken. In determining the mobilities the method used is practically that devised by Franck and Pohl [see Abstract No. 868 (1907)]. It is found that the mobility of the positive ions made by the α-rays from polonium in air varies inversely with the pressure up to 100 atmospheres. At high pressures the mobility of the negative ions made in air by the α-rays from polonium does not appear to vary inversely with the pressure, but seems to decrease less rapidly with the pressure than it should if it followed this law. The mobility of these negative ions also apparently varies with the strength of the field in which the ions are produced. A. E. G.

545. *Mobility of the Positive and Negative Ions in Gases at High Pressures.* **A. F. Kovarik.** (Roy. Soc., Proc. Ser. A. 86. pp. 154–162, Jan. 31, 1912.)—The mobilities of the positive and negative ions in dry air, dry hydrogen, and moist CO_2, have been measured. The method employed is based on Rutherford's equation [Abstract No. 2147 (1901)] for the velocity of ions between two plates, namely, $i = 9V^2K/32\pi d^3$, where i is the current per cm.^{2} through the gas, K the mobility of the ions, V the p.d., and d the distance between the plates. The assumption in the derivation of the above equation is that a strong surface ionisation exists at one of the plates, and this was satisfied experimentally by using the α-particles from ionium as the ionising agent, and reducing their range by employing the gases at high pressures. The equation was tested experimentally. The results for the mobilities are as follows: In dry air and dry hydrogen the mobility varies inversely as the pressure up to 75 atmos., the highest pressure used. In moist CO_2 the product of the mobility and pressure is constant for pressures up to 40 atmos., but for higher pressures the product decreases as the gas approaches the liquid state. The mean values for the products of the mobility and pressure expressed in atmospheres, for the range of pressures for which the product was constant, are, for the negative and positive ions respectively, in dry air, 1·89 and 1·346; in dry hydrogen, 8·19 and 6·20; and moist CO_2, 0·67 and 0·705 cm. per sec. for a potential gradient of 1 volt per cm. E. M.

546. *Attainment of Saturation in Ionisation by α-Rays.* **S. Meyer and V. F. Hess.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1187–1198, July, 1911. Communication from the Inst. f. Radiumforschung.)—The authors have investigated the saturation curves for air ionised by the α-rays (1) of polonium, (2) from a dry radium salt, and (3) of ionium. The ionisation chamber used was hemispherical. In agreement with previous observers it was found that saturation is obtained for a smaller field the less intense the source. Comparison of the saturation curves under identical conditions with the three bodies showed differences in their form. That for polonium rises initially much steeper than those of the other two, and also attains a maximum sooner. The curve for ionium rises initially less steeply than that for Ra, but later more steeply. The variation in the shape of the ionisation curve with different sizes of ionisation chambers was also investigated. E. M.

547. *Charges on Thermions produced in Air and Hydrogen at Atmospheric Pressure.* **J. C. Pomeroy.** (Phil. Mag. 23. pp. 173–182, Jan., 1912.)—The method adopted is practically the same as that used by Townsend in his work on ions produced by secondary Röntgen radiation [see Abstract No. 518 (1909)]. The essential part of the method is to have the ions moving in a uniform field and then examine the distribution in some particular case. A theory for the distribution of the ions has been worked out by Townsend from Maxwell's equations for the diffusion of one gas into another, and an outline of it is given here. In the early stages of the experiments the average charge on the positively-charged particles given off by the heated Pt appeared to vary from that given by Ra to nearly twice this value, while the value given by the negatively-charged particles seemed more constant and approximated to twice that given by ions produced by the Ra particles. This being contrary to what might be expected, various reasons are suggested and tested. It would seem that at a temperature only sufficiently high to give positive ionisation some of the ions from a fresh strip, or from one which has been resting in air, carry charges which are double the atomic charge; but when this strip is heated for a time a gradual change takes place, and as the large initial positive leak dies away a smaller and smaller proportion carry double charges, until a steady state is reached where the average charge is nearly equal to the atomic charge. The negative ions at all times carry double charges; but since at higher temperatures the average positive and negative charges are about equal, it would seem that at a sufficiently low temperature the negative ions may carry only single charges. It is found that, in hydrogen, negative as well as positive ions carry single charges only when obtained from a strip at the lower temperature, and when this temperature is raised both positive and negative ions carry some double charges. The proportion of these double charges to the whole number of ions rises gradually with the temperature of the strip just as with positive ions in air. Some experiments were carried out with positive ions from nichrome, but these were not of a satisfactory nature. Experiments on the velocity of the ions are in progress; results obtained up to the present show that the max. velocity does not vary with the temperature of the wire. A. E. G.

548. *Positive Thermions from the Salts of the Alkaline Earths.* **C. J. Davisson.** (Phil. Mag. 23. pp. 121–139, Jan., 1912.)—Richardson has shown [Abstract No. 258 (1911)] that the values of *e/m* for the positive thermions emitted from various salts of the alkali metals indicate that these ions are single atoms of the metal minus single electronic charges. The present paper deals with an account of determinations of *e/m* for the positive thermions from various salts of Ba, Sr, Ca, Mg, and Zn. The method employed is similar to that of Richardson. A strip of Pt-foil is coated with the salt under test and heated by an electric current. A movable plate with a slit is placed opposite the Pt-foil and a second plate connected to an electrometer is placed behind the slit. A magnetic field is applied parallel to the slit (and strip) and an electric field at right angles. The current received by the back plate is noted for different positions of the slit, the whole apparatus being highly evacuated. The value of *e/m* is calculated from the position of the slit for the max. current. The results of the experiments point strongly to the conclusion that the characteristic positive thermions from salts of all the above metals are single atoms of the elements minus single electronic charges, thus agreeing with the results of Richardson. In some cases values of *e/m* corresponding to K and Na were found, these being traced to impurities. [See next Abstract.] E. M.

549. *Rôle played by Gases in the Emission of Positive Thermions from Salts.* **C. J. Davisson.** (Phil. Mag. 23. pp. 139–147, Jan., 1912.)—The experiments are in continuation of those described in the preceding Abstract. In the above experiments the pressure of the gas in the apparatus was kept below 10^{-4} mm. The results of Garrett and Horton, however, have shown that at constant temperature the nature of the ions depends in a very marked way on the pressure and nature of the surrounding gas [Abstracts Nos. 117, 650 (1911)]. In the present paper this question is examined, using the above method, and the following conclusions are arrived at: (1) CO or CO_2, which is sometimes emitted by samples of salts when heated, is uncharged. (2) The increase of thermionic emission from a salt, which is caused by the presence of a gas in contact with its surface, is not due to an emission of gas atoms or molecules that have been absorbed by the salt and are emitted in a charged condition. E. M.

550. *Photoelectric Effect caused by Incident and Emergent Light.* **O. Stuhlmann, Jr.** (Phil. Mag. 22. pp. 854–864, Dec., 1911.)—When a beam of ultra-violet light impinges on a film of Pt so thin that its absorption can be neglected, the photoelectric effect caused by the emergent beam is about 1·15 times greater than that caused by the incident beam [Abstract No. 260 (1911)]. The present paper determines this ratio for a number of different metals obtained in sufficiently thin films by sputtering in a vacuum. The "forward effect," as the author terms the ratio, was found to be 1·06 in Mg, 1·02 in Fe, 1·08 in Cu, 1·11 in Zn, 1·07 in Ag, 1·15 in Sn, 1·17 in Pt, and 1·12 in Pb. The figures indicate a periodic variation of the forward effect with the atomic weight, but there may be a selective action depending on the wave-length, and experiments with monochromatic light are called for. The results suggest arguments in favour of the corpuscular structure of light. E. E. F.

551. *Selective Photo-effect in Lithium and Sodium.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 46–59, Jan. 30, 1912.)—A selective photo-effect has already been proved to exist in Rb, K, and Na, the photoelectric emission of electrons having a maximum for a certain wave-length at a certain azimuth of incidence. Li cannot be fused in glass, quartz, or Pt without attacking the vessel. The authors therefore fused it on sheet-iron in a vacuum. Traces of Na distilled out first. Then a metallic layer of Li was deposited on the glass, and simultaneously on a small Pt crucible fixed above the Li. The resonance maximum for Li lies at about 280 $\mu\mu$. The same method, used for Na, gave a maximum at 340 $\mu\mu$. These values, as also those given for K and Rb and alloys, can only be relied upon within $\pm 10\,\mu\mu$. The maximum for

Li differs from Lindemann's calculated value by 50 $\mu\mu$, and that for Na by 20 $\mu\mu$, while those of Rb, K, and Ba coincide. Haber's relation $\lambda_v = 42{\cdot}8\,(\text{mol. wt.})^{\frac{1}{2}}\,\lambda_r$ is in satisfactory agreement with the value for Li. E. E. F.

552. *Theory of Photoelectric Current in Gases.* **A. Partzsch.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 60–73, Jan. 30, 1912.)—Tests Stoletow's relation $v/lp_m = NV =$ const., where v is the p.d., l the distance between the electrodes, p_m the pressure in mm. of Hg, which gives the max. photoelectric current, V the ionisation potential, and N the number of collisions encountered by an ion traversing 1 cm. of a gas at a pressure of 1 mm. of Hg. V is found to vary from 27·9 in nitrogen to 23·5 in CO_2. It is probably the smaller, the more electro-negative the gas. N is 5·5 in hydrogen, and 16·2 in CO_2. The mean free path of an ion is from 10 to 12 times as long as that of a molecule of the gas itself. Stoletow's constant NV ranges from 153 (H) to 380 (CO_2), as against the corresponding values 130 and 466 found by Townsend. In CO_2, as the p.d. increases from 41 to 320, NV approaches a limiting value of about 380, being as low as 314 at 41 volts. Since no maximum occurs when $v < V$, only $l(1 - V/v)$ need be considered, as regards ionisation by collision, and this value should be substituted for l in Townsend's formula for the photoelectric current. E. E. F.

553. *Photoelectric Effects of Certain Compounds.* **A. L. Hughes.** (Cambridge Phil. Soc., Proc. 16. pp. 376–383, Dec. 1, 1911.)—Our knowledge of the ionisation by ultra-violet light is mainly derived from experiments on the emission of negative electricity from metallic surfaces exposed to light. The number of experiments recorded on the ionisation of gases by ultra-violet light is small in comparison. The difficulty of experiment lies in the small wave-length necessary, that for appreciable ionisation in air being, for instance, less than λ1350. The author has therefore tried various gases to find one which could be ionised at ordinary temperatures for light of moderate wave-length. It appeared most likely that the desired result would be obtained with vapours containing elements which are known to be photoelectric. The vapours tried were carbon disulphide, carbon dioxide, tin-tetrachloride and zinc ethyl. In no case was any trace of ionisation observed, using the light from a mercury arc (shortest wave-length about λ2300). For the same amount of light energy, the leak from a zinc or carbon surface would have been of the order 10^6 times that of the smallest effect which could be measured in the experiments. Some experiments were also made on the photoelectric properties of a few solid compounds, which were compared with a zinc plate under similar conditions. The photoelectric current in terms of zinc varied according to the treatment of the compounds, and was about 0·1 for $ZnSO_4$, for instance, and 0·8 for NaOH. E. M.

554. *Velocities of Kathode Particles ejected by Characteristic Röntgen Radiations.* **R. Whiddington.** (Cambridge Phil. Soc., Proc. 16. pp. 326–330, Dec., 1911.)—The experiment of producing secondary kathode particles by means of characteristic radiations, and directly measuring their velocity, has not yet been successfully attempted. The present paper is of a preliminary nature, and consists mainly of a discussion of the results recently obtained by Sadler and by Beatty, from which it is concluded that the radiation characteristic of an element of atomic weight w is the same as the most penetrating rays produced by impact against a target, of a stream of kathode

rays moving with velocity $v_p = kw$. So that the energy-transformations occurring between the arrest of the parent kathode rays within a Röntgen bulb and the subsequent liberation of secondary kathode rays from a distant tertiary radiator may be considered, as follows: *Primary kathode rays* of velocity just greater than $v_p = kw$ give rise to *primary Röntgen rays*, which give rise to *secondary Röntgen rays*, characteristic of element of atomic weight w, which give rise to *secondary kathode rays* (from any tertiary radiator) of velocity $v_s = k'w$. To complete these relations it will be necessary to determine the constant k'. Experiments are in progress. A. E. G.

555. *Rays of Positive Electricity from Wehnelt Kathode.* **C. T. Knipp.** (Phil. Mag. 22. pp. 926–938, Dec., 1911.)—A photographic plate inside the discharge tube has been used for the measurement of the rays of positive electricity in the case of the ordinary perforated kathode. With the hot lime kathode, the velocity of the positive carriers is too small to affect a photographic plate on which they strike. These slowly-moving particles can be accelerated at will, the minimum p.d. required to give them a sufficient velocity to affect the plate being found to be about 500 volts per cm. The vacua employed are the highest that can be obtained by the aid of liquid air with charcoal. All the photographs obtained show two, and on several plates three or four, lines. These vary greatly in sharpness and intensity from plate to plate. Two types of curves are obtained: First, those that are straight lines passing out from the origin; and secondly, parabolas having their heads in the same vertical line. Taken collectively, the photographs show the two hydrogen lines, a line of atomic weight 4, the carbon atom with two charges, the carbon atom with one charge, the oxygen atom with one charge, another line of atomic weight 22 that was visible on three different plates, and a final line corresponding to CO_2 with one charge. The value of e/m for the various carriers is thus the same as that found by J. J. Thomson, for positive rays formed by ordinary perforated kathodes with high-potential discharge. The parabolas extend nearer the origin, and the photographs are more clearly defined, the greater the acceleration employed. No negative counterpart to any of the curves is noticed. This communication, which is of a preliminary nature, deals only with results obtained in residual air. A. E. G.

556. *Production of a Helix of Rays from the Wehnelt Kathode.* **C. T. Knipp.** (Phys. Rev. 34. pp. 58–61, Jan., 1912.)—The hot lime kathode furnishes a convenient method of obtaining a compact beam of kathode rays direct from the source and without the use of diaphragms. This makes it possible to perform, with very simple apparatus, such as is described in the present paper, a number of experiments on the magnetic and electrostatic deflection of these rays. A special method of constructing the kathode for this purpose is described, and the results obtained with it should be of interest to those giving courses on recent advances in experimental physics. A. E. G.

557. *Formation and Velocity of Negative Ions in Canal Rays.* **J. Koenigsberger** and **J. Kutschewski.** (Deutsch. Phys. Gesell., Verh. 14. 1. pp. 1–8, Jan. 15, 1912.)—Various other observers are of opinion that the negative ions in oxygen are due to the presence in the discharge tube of water-vapour, and possibly of other compounds containing oxygen. The same explanation will serve for the negative ions in hydrogen. It is now found that all canal-ray ions are originally positive, irrespective of whether they become positive or negative later. The velocity of the negative portion is always smaller than that of the positive. The formation of the negative ions is brought about at the seat of ionisation more particularly by rays of smaller velocity. A. E. G.

558. *Transmission of Kathode Rays through Matter.* **R. Whiddington.** (Cambridge Phil. Soc., Proc. 16. pp. 321–325, Dec., 1911.)—Kathode rays lose velocity on passing through matter, the change being greater for slow than for fast rays. A similar effect exists in the case of β-rays. The experiments now described with kathode rays are similar to those carried out by W. Wilson on β-rays [see Abstract No. 1438 (1910)]. When using a single thickness of copper-leaf it is clear from the table of results that $v_0^4 - v_x^4 =$ constant, where $v_0 =$ velocity of incident rays on a metal sheet of thickness x and $v_x =$ the velocity of the rays transmitted through the sheet. When different thicknesses of leaf are used it appears that J. J. Thomson's formula $v_0^4 - v_x^4 = ax$ is true. In order to determine the constant a with any accuracy it is necessary to make a great many determinations. This has been done for Al, in which case $a = 7{\cdot}32 \times 10^{42}$. It is shown by reference to W. Wilson's results obtained with high-speed β-rays from Ra on passing through 0·0245 cm. of Al that the above kathode-ray formula holds for the slowest of the β-rays as the calculated values of v_x differ from the observed values by less than 1 per cent. A. E. G.

559. *Influence of Magnetic Field on Gaseous Conductivity.* **A. Righi.** (Le Radium, 8. pp. 415–416, Nov., 1911.)—The transformation of kathode rays into magnetic rays is not only accompanied by a sudden and considerable variation in the p.d. [see Abstract No. 1432 (1909)] but also by a similar variation of the current in the opposite sense. The critical values of the magnetic field below or above which magnetic rays are not formed are about 600 and 1200 gauss respectively. The magnetic rays, consisting of neutral doublets, do not, of course, convey an electric current. E. E. F.

560. *Sparks in Air under the Action of a Magnetic Field.* **A. Righi.** (Comptes Rendus, 154. pp. 104–108, Jan. 15, and pp. 488–490, Feb. 19, 1912.)—The discharge in the form of a spark is obtained in air at 1/10 to 1/100 mm. pressure. If a large glass bulb is employed the modifications produced on the discharge by a magnetic field are remarkable. The phenomenon differs greatly from known effects. Experiments are described in which a small mill with mica vanes similar to that used in the radiometer is employed in the discharge tube, and the results obtained are confirmed by substituting a Faraday cylinder for the mill. It appears from these that there is an emission of positive ions and negative electrons, the former maintaining the direction of their movement for a long time, probably on account of their mass. A measure of the intensity of the bombardment may also be made by ascertaining the torsion of the suspension of the mill. Generally, with the most favourable pressures for magnetic rays the magnetic field is found to cause an increase in the bombardment effect upon the mill. An experiment is described in which two small mills are employed in a tube, one above, the other below the discharge. The results obtained with this by the use of a magnetic field seem to give a strong support to the theory of magnetic rays in which the existence of neutral doublets is postulated. In the second paper an explanation is given of the rotations of the small vanes produced by the ions, and an experiment is described in which certain rotations are produced only under the action of the magnetic field. A. E. G.

561. *Spark Discharge in Gas at Low Pressures and its Alteration in the Magnetic Field.* **A. Righi.** (Phys. Zeitschr. 13. pp. 65–73, Jan. 15, 1912. Paper read before the R. Acad. Sci. dell. Ist. di Bologna, Nov. 22, 1911.)—This is a more complete account of the phenomena described elsewhere [see preceding Abstract]. The subject is divided into the following sections: (1) Starting-point of the research [Abstract No. 1545 (1911)]. (2) Generation of the spark discharge in gases at low pressures. (3) Apparatus required. (4) Spark discharge in air at low pressures. (5) Change which takes place in the form of the spark owing to the action of the magnetic field. (6) Alteration of the positive light-column. (7) The case in which the ends of the electrodes lie on the axis of the magnetic field. (8) Action of the magnetic field on the particles emitted by the spark. Diagrams of the apparatus and two plates showing the photographic representation of the effect are given. A. E. G.

562. *Condition of Existence of Arc between Carbon Poles.* **A. Occhialini.** (N. Cimento, 2. Ser. 6. pp. 329–336, Nov., 1911.)—From a study of kinematographs of the electric arc between carbon poles, it is concluded that under ordinary conditions, with a cold anode, there are two distinct phases in the formation of the arc, the first having the character of a scintillation, the second, termed the *autonomous phase*, that of the arc proper. A cold anode is essential to the existence of the first phase, a hot anode for the latter, so that the first prepares the condition necessary for the second. By using a rotating carbon disc as anode the first phase may be prolonged, since the anode does not get warm, and by starting with a hot anode the autonomous phase may be reached without any preliminary sparking. The gas emitted by the anode during the explosive phase gives a line spectrum, that given off during the autonomous phase a band spectrum. W. H. Si.

563. *Development of Luminosity in the Electric Arc.* **A. Occhialini.** (N. Cimento, 2. Ser. 6. pp. 431–436, Dec., 1911.)—Kinematographs of the various phases in the production of the electric arc under ordinary conditions, using a warm kathode, and p.d.'s of 70 and 220 volts, show that the luminosity commences at the anode and spreads across to the kathode. This is attributed to an invisible discharge travelling in the opposite direction, since, when a condenser of 6 mfd. is placed in parallel with the electrodes, the discharge becomes visible travelling in that direction. W. H. Si.

564. *Potential Gradient in the Unstriated Positive Column of the Glow and Arc Discharges.* **W. Matthies** and **H. Struck.** (Deutsch. Phys. Gesell., Verh. 14. 2. pp. 83–103, Jan. 30, 1912.)—A method of measuring the potential gradient by means of metal rings placed round the outside of a cylindrical discharge tube has previously been described [see Abstract No. 1556 (1911)]. The first portion of the present paper deals with experimental evidence to prove that the gradients obtained by this new method are reliable. Then results obtained in nitrogen and hydrogen are given. In the former gas, with high pressures and large currents, it is found that (1) in the positive column the alteration of the gradient with the pressure is qualitatively similar to that with low gas-pressures and small currents; (2) the gradient in the glow or arc discharge at higher pressures is a linear function of the pressure; (3) the rise in the gradient with the pressure is *ceteris paribus* so much the steeper the smaller the current; (4) the decline of the gradient with the current increases strongly with increasing pressure; (5) contrary to observations at low pressures (under 1 mm.), where an asymptotic approximation to a limiting value is established, at higher pressures (between 4 and 160 mm.) no such approximation is found; (6) the change of velocity with currents 0 to 12 amps./cm.^{2} is extraordinarily large; it gradually diminishes with larger currents. This change is so much the greater the smaller the influence of the tube walls upon the current. The influence of the tube diam. is specially considered. The results of the experiments on the gradient in hydrogen are qualitatively similar to those in nitrogen. The chief points in which they differ quantitatively are stated. A. E. G.

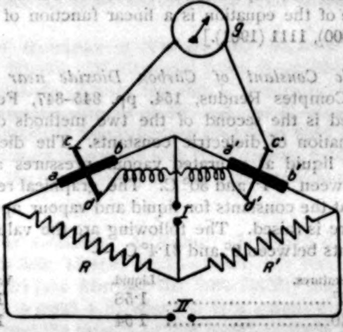
565. *The High-voltage Corona in Air.* **J. B. Whitehead.** (Amer, Phil. Soc., Proc. 50. pp. 874–896, July–Aug., 1911.)—A complete theoretical discussion of experimental results recently obtained by the author on the high-voltage corona in air is given. The practical bearing of these results in engineering work is discussed in another paper [see Abstract No. 676B (1911)]. The most interesting problem discussed is why the properties of air round a cylindrical conductor should change when its diam. is slightly altered, although the diam. of the conductor is 50,000 times as great as the mean free path of a molecule. It has been suggested that a layer of ions has been attracted to the conductor, and thus the potential gradient at its surface has been altered. But if this were true the corona voltage would be affected by the amount of ionisation present, and this is contrary to observation. By a sensitive optical method also the writer proved that the increase of air pressure at the surface of the conductor must be negligibly small. The explanation will probably be connected with the diminution of the surface of the smaller conductors. Secondary ionisation probably begins with the collisions of a few electrons which have free paths longer than the average. With decreasing area of conductor, the number of neighbouring electrons whose free paths exceed a certain length, and at the same time are subject to the max. electric intensity, will be decreased, and consequently the corona-forming electric intensity must be higher. A. R.

566. *Disruptive Discharges of Electricity through Flames.* **F. E. Nipher.** (Amer. Phil. Soc., Proc. 50. pp. 397–408, July–Aug., 1911.)—The author has previously pointed out the essential difference in character between the effects of Röntgen rays in the ionisation of the air and that produced in a column of air exposed to the positive terminal of an influence machine [see Abstract No. 742 (1910)]. Photographs are now given which illustrate the effect produced in air at the positive terminal, and also an attempt is made to compare the conductivity of such a column of air with that of the flame of a blast lamp. It appears that the conduction of the gases within the flame of the lamp is very much less than that in the positive column near the anode. A. E. G.

567. *Electrical Discharge from a Point to a Plane.* **O. Hovda.** (Phys. Rev. 34. pp. 25–38, Jan., 1912.)—Warburg has investigated the effect of distance between a point and a plane upon the current flowing for a given potential for distances up to 7 cm. [see Abstracts Nos. 275, 458 (1899), and 1341 (1900)]. The author has experimented to much greater distances. He has found the law according to which the minimum potential required varies with the distance, and also how the current varies with the potential at the different distances. The general arrangement used was similar to that employed

by Zeleny, and a carbon ruled paper [see Abstract No. 1578 (1911)] was used to regulate the static voltage. The results are reduced to 22° C. and 74 cm. pressure by Zeleny's laws. The plane used was a circular zinc plate 830 cm. in diam. The discharge-point was the hemispherical end of a Pt-wire 1·75 cm. long, and 0·018 cm. in diam. A formula of the form $V = a + b/(c + \sqrt{D})$ is found to give the minimum potential, where a, b and c are constants and D is the distance between the point and the plane. The currents were found to increase rapidly with the voltage when the distances were small, but they increased slowly with increasing voltage for larger distances. The potential gradients along the normal from a discharge-point to a plane decrease rapidly as the point is receded from, pass through a minimum, and then increase near the plate. The gradients at any point have been found to be proportional to the square root of the current flowing. Except for the shortest distances the potential gradient for a positive current of given value bears a constant ratio to the potential gradient for the negative current of the same value. A. R.

568. *Resonance Determination by Null Method.* **L. Isakow.** (Phys. Zeitschr. 12. pp. 1224–1226, Dec. 15, 1911.)—An arrangement is described, which determines the quantity $A = \int i_1 i_2 dt$, where i_1, i_2 are the momentary currents in two coupled condenser circuits. The arrangement may therefore be used for resonance determinations, since, at resonance, A = 0. The arrangement is shown in the Fig. *ab*, *a'b'*, are thermo-elements of equal resistance and sensitiveness; R, R', are equal inductionless resistances; the coil joining *dd'* is of high self-induction and low resistance, I and II are connected to two coils, of similar construction, which are loosely coupled to the primary and secondary circuits respectively. It is obvious that the galvanometer deflection indicates the quantity A. As used in the laboratory, the arrangement is found to be very sensitive. [See also Abstracts Nos. 1010B and 1825 (1910).] T. P. B.



569. *Propagation of "Wireless" Waves round the Earth.* **H. W. March.** (Ann. d. Physik, 37. 1. pp. 29–50, Dec. 29, 1911.)—A mathematical paper, which is an extension of a paper by Sommerfeld, on the propagation of "wireless" waves along a plane separating two media of different characteristics, to propagation around the earth's sphere [see Abstract No. 1181B (1909)]. The earth is supposed to be perfectly conducting. The electromagnetic field of the sender is expressed in the form $\partial/\partial\theta.(\Delta\pi + k^2\pi) = 0$, and the expression giving the potential function π at any point on the earth's surface is found to be $\pi = 2e^{-ika\theta}/a\sqrt{\theta \sin\theta}$, where $a\theta$ is the spherical distance of the point from the sender and $k^2 = (\epsilon\mu w^2 - i\mu\sigma w)/c^2$; here ϵ, μ, σ are respectively the dielectric constant, permeability and conductivity of the air, $w = 2\pi$ × frequency, and c = the velocity of light. θ must not be taken too small or too nearly equal to π. This conclusion is considered much more in accord with the results of wireless telegraphy than those of Nicholson and Poincaré [see Abstracts Nos. 1130 (1910), 882 (1912)]. T. P. B.

570. *Further Observations on the Afterglow of Electric Discharge.* **R. J. Strutt.** (Phys. Soc., Proc. 24. pp. 1–8; Discussion, p. 8, Dec. 15, 1911.)—[See Abstracts Nos. 518, 622 (1911).]

ELECTRICAL PROPERTIES AND INSTRUMENTS.

571. *Results of Kinetic Theory of Dielectrics.* **P. Debye.** (Phys. Zeitschr. 13. pp. 97–100, Feb. 1, 1912.)—Taking the view that in dielectrics the electrons when displaced are urged back by forces proportional to those displacements, and that *dipoles* of constant electric moment are present also, the author obtains the following expression: $T(\epsilon - 1)/(\epsilon + 2) = a + bT$, where ϵ is the dielectric constant, and T the absolute temperature. This theoretical result is compared with experimental values and curves are plotted showing that the left side of the equation is a linear function of T. [See Abstracts Nos. 133, 135 (1900), 1111 (1901).] E. H. B.

572. *Dielectric Constant of Carbon Dioxide near its Critical Point.* **L. Verain.** (Comptes Rendus, 154. pp. 345–347, Feb. 5, 1912.) — The method employed is the second of the two methods described by Drude for the determination of dielectric constants. The dielectric constants of CO_2 vapour and liquid at saturated vapour pressures are determined for temperatures between −4° and 30° C. The graphical representation of the results shows that the constants for liquid and vapour approach one another as the temperature is raised. The following are the values obtained for the dielectric constants between 0° and 31·4° C.:—

Temperatures.	Liquid.	Vapour.
0°	1·58	1·04
10	1·54	1·07
20	1·48	1·11
30	1·32	1·20
31·4	1·25	1·25

A. E. G.

573. *Condensers with Kerosene as Dielectric.* **S. H. Anderson.** (Phys. Rev. 34. pp. 34–39, Jan., 1912. Elect. Rev. and West. Electn. 59. p. 1181, Dec. 9, 1911. Abstract of paper read before the Amer. Phys. Soc., Dec. 2, 1911.)—The capacity of a parallel plate condenser with kerosene as the dielectric was found to be unaffected by frequency for a range of 1 to 1,600,000. Consequently this type of condenser is very desirable to use for work in electric oscillations, as the value of the capacity obtained for low frequencies holds for high frequencies. The most satisfactory method of measuring small capacities was found to be the Fleming-Clinton rotating commutator scheme. F. E. S.

574. *Effect of Magnetic Fields on Metallic Resistance.* **C. W. Heaps.** (Phil. Mag. 22. pp. 900–906, Dec., 1911.)—Changes of resistance due to transverse and longitudinal magnetic fields were measured in specimens of iron, nickel, cadmium, and the Heusler alloy. The resistance was observed by means of a Wheatstone bridge arrangement, and the magnetic fields were produced either by an electromagnet or a solenoid; with the electromagnet fields up to 10,000 could be obtained. The metallic specimens were immersed in oil or water, which was kept moving to prevent variation of temperature. The results are given in the form of curves, and the author has arrived at the following conclusions: (1) The increase of resistance of iron and nickel in longitudinal magnetic fields approaches a maximum, but does not grow less after reaching the maximum. For transverse magnetisation of these metals there is, as found by Grunmach, first an increase and then a decrease of resistance as the magnetic field increases. (2) For cadmium the increase of resistance in both longitudinal and transverse fields is, as required by Drude's theory, approximately proportional to the square of the field strength. The transverse effect is the larger. (3) For the Heusler alloy there is decrease in resistance in both longitudinal and transverse fields; and for large fields the change is proportional to the field strength. In the case of longitudinal magnetisation, however, the effect may approach a maximum as measurements could not be made in stronger fields than 10,000. The behaviour of the Heusler alloy is very unlike that of the other metals, and with the exception of the Kerr-effect this is the only respect in which its magnetic properties are markedly different from those of iron. J. J. S.

575. *Variation of Resistance of Mercury and Bismuth Amalgams in a Magnetic Field.* **G. Rossi.** (N. Cimento, 2. Ser. 6. pp. 337–348, Nov., 1911.) —The electrical resistance of pure Hg and of amalgams containing 0·5 and 1 per cent. Bi, or saturated with Bi at 12° and 190° C., rises when these are placed in magnetic fields of intensities varying from 3350 to 4450 gauss, the variation in the resistance increasing with the magnetic field, the diam. of the tube containing the Hg or amalgam, and the concentration of the amalgam. W. H. Sr.

576. *Inductance of Solenoids.* **A. Esau.** (Jahrbuch d. Drahtlosen Telegraphie, 5. pp. 378–382, March, 1912.)—Strausser's formula for the self-induction of a solenoid [see Abstract No. 2090 (1905)] may be written in the form $L = 4\pi rn(lnr/\rho + 0{\cdot}333 + S)$, where S is a quantity dependent on the number of turns, *n*, and the ratio, *c*, of the length of the solenoid to its diam. Tables are here provided giving S for values of *n* from 2 to 30, and values of *c* from 0·06 to 1·75. By means of these tables the calculation of the self-induction is made much easier. The maximum of self-induction of such coils lies at a value of *c* of about 0·4, but at a slightly less value as the pitch is increased. T. P. B.

577. *Formulæ and Tables for the Calculation of Mutual and Self-inductance.* **E. B. Rosa** and **F. W. Grover.** (Bureau of Standards, Bull. 8. pp. 1–237, Jan. 1, 1912.)—This paper is an extension and revision of a previous paper by Rosa and Cohen [see Abstract No. 1841 (1908)]. It is now by far the most complete and thorough study of the subject that has yet been published. The authors have taken great pains to bring it thoroughly up to date, and have made a critical study of nearly all the recent papers on the subject. The comparisons of the results obtained by various authors and the investigations of the convergence of the various series that have been proposed have cleared up the whole subject admirably. To help other investigators complete numerical tables are given. For example, complete tables are given of the functions required for calculating the resistance and inductance of straight cylindrical wires for alternating currents of various frequencies, and also the asymptotic values of the inductance at high frequencies for straight and parallel wires and for circular rings. [In formula (47), p. 68, the coefficient of the second term should be $8\pi(A+a)/3$ and not $32\pi Aa/\{3(a+A)\}$ as printed.] A. R.

578. *The Induction Coil.* **E. T. Jones** and **D. E. Roberts.** (Phil. Mag. 22. pp. 706–720, Nov., 1911.)—The experiments described were made with the object of determining the periods, amplitudes, damping-factors, and phases of the two electrical oscillations set up in the secondary of an induction coil when the primary current is interrupted. From the data so obtained the value of the secondary potential at every instant during the oscillations is calculated. The results show that the simple theoretical formula for the secondary potential gives to a first approximation the observed values when the current is interrupted in the primary. In the actual experiments it was noticed that there was some uncertainty with regard to the max. value of the p.d. This was due to the fact that the amplitude of the oscillograph wave was not always the same with the same primary current. Oscillograms obtained when a motor mercury-interrupter of the centrifugal type was employed are given. A. R.

579. *Measuring Instruments depending on Heat Effect. I. The Barretter.* **M. K. Grober** and **H. Zöllich.** (Phys. Zeitschr. 12. pp. 1048–1058, Nov. 15, 1911.)—This article, which is the first of a series giving the theory of measuring instruments based on heat effect, deals specially with the barretter. The theory of the distribution of heat along the barretter wire is developed, and the theoretical curve is shown to have the same form as the experimental. The sensitiveness of the barretter will depend upon the rate of change of the resistance of the wire with the current passing through the wire. The theoretical curve shows that this rate of change is a maximum for a particular current strength. Experiments have shown that the barretter is most sensitive for a particular current strength, but the current strength at greater sensitiveness does not quite coincide with that for greater rate of change of resistance. It is slightly in front of the latter. The problem of measuring an incident oscillation train by means of a barretter, connected as in practice, is then dealt with theoretically. T. P. B.

580. *Arc Interrupter.* **A. Guillet.** (Comptes Rendus, 153. pp. 866–867, Nov. 6, 1911.)—Describes a form of automatic interrupter for induction coils which requires lower e.m.f.'s than the Wehnelt type. Mercury is covered with a layer of alcohol, and the cup is closed by means of a stopper through which a graphite electrode passes. The latter is adjusted until its point touches its image. The mercury is made the kathode, and the coil works automatically and regularly from the first. The voltage used is 10 to 40, and the apparent current about 5 amps., or 1 to 3 amps. if the 110-volt supply is used. The Fizeau condenser must be in circuit, and the inductance of the secondary must be very feeble. The cup may contain an atmosphere of alcohol vapour, hydrogen, or coal gas, but not of air. The carbon anode may be replaced by an iron or other kathode. Powerful sparks are obtained with

a Cu kathode. If prolonged action is desired, a cooling arrangement is advisable. This may consist of a serpentine tube round the carbon, through which cold water circulates. E. E. F.

581. *Construction of Selenium Bridges.* (Electrical World, 59. p. 251, Feb. 8, 1912.)—Describes a "cell" devised by O. Lindner and J. B. Replogle resembling in some respects the Presser pattern. A thin film of Pt is deposited on glass. With a fine graving tool this metallic layer is scored to and fro to make a long gap between two conducting portions consisting of Pt. Selenium in the plastic form is then pressed against the plate, filling the scratches and bridging the gap. It is then sensitised by annealing. Light is admitted through the glass, and also penetrates the thin film of Pt. E. E. F.

582. *Simple Apparatus for Alternating-current Demonstrations.* **G. Hoffmann.** (Phys. Zeitschr. 13. pp. 80–81, Jan. 1, 1912.)—The apparatus comprises two small electromagnets with laminated cores and nearly closed magnetic circuits, mounted horizontally on brass pillars on an iron base-plate. Each magnet is provided with two windings, one of which carries a continuous current (0·7 amp.) supplied direct from a 2-volt accumulator. The second winding in one case is of fine wire and in the other case of large wire, and these carry the alternating currents to be studied. Each magnet acts on a movable system consisting of a light horizontal rod supported from the base-plate by a thin vertical steel rod, to which are also fixed an adjustable weight and an armature which is drawn into the air-gap of the magnet. The pulsating forces acting on the armatures are horizontal, and perpendicular to the length of the horizontal rods which are consequently made to vibrate in horizontal planes. The two rods differ slightly in height and cross each other at right angles. The lower one is bevelled and polished so as to reflect upwards a beam of light directed on it from one side; the upper one is blackened. When both are vibrating and are viewed from above, the path of the point where they cross is seen as a straight line, ellipse or circle, according to the relative amplitudes and phase-displacements of the alternating currents. The natural periods of the two moving systems should be adjusted to be as nearly as possible equal; this will be the case if, when they are disturbed by hand, the shape of the figure described remains constant as the vibrations die out. The adjustment should preferably be such that the natural period is a little above the period of the alternating currents. By means of an arc lamp, &c., a clear image can be thrown on a screen at several yards' distance. F. T. C.

583. *New Half-ring Electromagnets.* **H. du Bois.** (Zeitschr. Instrumentenk. 31. pp. 362–378, Dec., 1911.)—The present paper begins with an historical summary of the evolution of powerful electromagnets up to the form now described by the author. The following part, descriptive of the electromagnets, made by Hartmann and Braun is, with fuller technical details, as given in Abstracts Nos. 2115 (1909) and 1760 (1910). Six different pole armatures are described which are suitable for special kinds of magnetic work, such as for oblique vision as required in magneto-optic work, a gradient pole armature for use in non-uniform fields as used by Curie, a thermomagnetic pole armature, a cryomagneto-optic pole armature, an attachment for observing the rise of liquids in the magnetic field, and one for observations in magnetic double refraction. G. E. A.

584. *Effective Resistance of Coils to Alternating Current.* **W. Lenz.** (Jahrbuch d. Drahtlosen Telegraphie, 4. pp. 481–489, May, 1911.)—A comparison of the theoretical results of Cohen, Nicholson, and Sommerfeld [see Abstracts Nos. 1569 (1907), 276 (1908), 457 (1910)]. The comparison is in favour of Sommerfeld's theory. T. P. B.

585. *Calculation of Moving Coils of Galvanometers.* **H. Diesselhorst.** (Zeitschr. Instrumentenk. 31. pp. 247–255, Aug., and pp. 276–288, Sept., 1911.)

586. *Self-induction and Capacity Measurements with a New Dynamometer.* **H. Zipp.** (Elektrotechn. Zeitschr. 33. pp. 182–185, Feb. 22, 1912.)—Largely mathematical and not suited for abstracting. An induction dynamometer is described and new methods are devised for the measurement of self-induction and capacity. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

587. *Magnetic Transition Temperature of Cementite.* **S. W. J. Smith, W. White** and **S. G. Barker.** (Phys. Soc., Proc. 24. pp. 62–67; Discussion, pp. 68–69, Dec., 1911. Electrician, 68. pp. 780–781, Feb. 9, 1912. Abstract.) —Experiments show that cementite loses its magnetic properties at about 240° C. The loss is not complete, but this is probably due to decomposition, with the production of iron. F. C. A. H. L.

588. *Magnetic Properties of Manganese and Nickel Steels.* **S. Hilpert** and **W. Mathesius.** (Zeitschr. Elektrochem. 18. pp. 54–64, Jan. 15, 1912.)—Tests have been made on the magnetic properties of nickel steel with 12 per cent. Ni, manganese steels with 5, 10, and 20 per cent. Mn, and on manganese-carbon steels with 10 per cent. Mn and 1 and 2 per cent carbon. The 20 per cent. Mn steel is practically non-magnetic after any thermal treatment. The best heat treatment for all the specimens was quenching at 400°–500° C., and quenching at 1200° gave better quality than quenching at 900° or slowly cooling from 750°. The presence of carbon in the 10 per cent. Mn steel caused an almost complete loss of susceptibility on quenching at 900°. The authors consider their tests to show that the metal when quenched at 1200° contains more magnetic particles than the metal quenched at 750°. The coercive force diminishes with increasing permeability for the heat treatment of the 5 per cent. Mn and the 12 per cent. Ni steels, but it increases and diminishes along with the permeability in the 10 per cent. Mn steel. A. D. R.

589. *Model of the Elementary Magnet.* **S. R. Williams.** (Phys. Rev. 34. pp. 40–47, Jan., 1912.)—The author considers the magnetic atom or elementary magnet to consist of a positive nucleus (in the shape of an oblate spheroid), about which one or more negatively charged electrons revolve as satellites. The nucleus has a permeability greater than unity, and has no retentivity. When the atom is placed in a magnetic field, two sets of forces are operative—one, due to the magnetisation of the nucleus, tends to set the equatorial plane parallel to the field; the other, due to the revolving electrons, tends to place the axis of revolution in the same position. The resulting effect depends on the initial position and on the strength of the applied field. A model was made of a Swedish soft-iron spheroid, with a current-carrying coil surround-

ing it in the equatorial plane. The movement of the model in the field in a large solenoid was investigated. On plotting curves showing the relation between the applied field strength and the length of the diam. of the spheroid parallel to the axis of the coil solenoid, figures were obtained similar to those for the increase of length on magnetisation of iron, nickel, cobalt, and the Heusler alloys. The different types of curve were obtained by altering the initial position of the axis of the spheroid and the strength of the current in its surrounding coil. A. D. R.

590. *Subsequent Magnetism of Iron.* **A. Bernini.** (N. Cimento, 2. Ser. 6. pp. 291–322, Oct., 1911.)—The law according to which iron introduced into a magnetic field assumes its final magnetisation is represented by the formula $\phi = A(1 - e^{-\lambda t^{1/3}})$, where A and λ are constants having values such as 7·5 and 1·05 respectively. The limits within which the above law holds good are 0·085 and 0·14 for the field and 15° and 150° for the temperature. The quality of the iron, its subdivision, and its orientation in the magnetic field are immaterial. When the field diminishes A and λ also diminish, and they decrease also when the specimen is subdivided. Both constants are greater for tubes than for solid cylinders, and they vary in the same sense from one specimen to another. On heating, λ remains nearly the same, but A decreases. Both constants have a smaller value when there is residual magnetism than when the specimen is completely demagnetised at the beginning of the test.
E. E. F.

591. *Earth Currents between Stations at different altitudes on Monte Rosa.* **A. Amerio.** (N. Cimento, 2. Ser. 6. pp. 437–444, Dec., 1911.)—Measurements of the earth currents between six stations on Monte Rosa, at altitudes of about 1200, 2000, 2900, 3647, 4231, and 4559 m., show that, except between the two highest points, where the opposite is the case, the higher station is always positive with respect to the lower, thus confirming the results obtained by Brunhes and David at Puy-de-Dôme [Abstract No. 1620 (1909)] that negative electricity tends to fall from higher to lower levels.
W. H. Sr.

592. *Origin of Terrestrial Magnetism.* **L. Steiner.** (Terrestrial Magnetism, 16. pp. 221–232, Dec., 1911.)—The author reviews the theories of Bauer [see Abstract No. 1240 (1911)] and Schmidt on the magnetism of the earth being chiefly due to external *negative* electric currents circulating overhead from west to east. He agrees with Bauer that the part of the homogeneous magnetisation of the earth's core generally ascribed to inner agencies could be produced by such currents, but he considers that the part of the permanent magnetic field ascribed to external agencies requires *positive* currents going from west to east. The difference of opinion arises on the following question. Bauer asserts that the lines of magnetic force pertaining to the current sheet do not progress continuously, but suffer a displacement because of a change in sign in the vertical component of the force—the horizontal component varying continuously. Steiner considers that the value of the component of magnetic force normal to the sheet is continuous, and so is the component of magnetic force parallel to the current-lines, but the tangential component perpendicular to the current lines is discontinuous at the sheet. **L. A. Bauer.** (Ibid. pp. 233–236, Dec., 1911.)—Bauer replies to Steiner's criticism. As to the question of the continuity of the component forces, he considers that in passing through the bounding surface enclosing the mag-

netising agencies, the vertical component of force must necessarily change sign while the horizontal component varies continuously. The result is that though for the outside magnetic potential the lines of magnetic force between the earth's surface and the supposed upper bounding surface proceed at the north pole upwards, when the upper surface is reached and penetrated they swing round, owing to the angular displacement suffered, and consequently, instead of emerging from the supposed surface they actually re-enter the surface. Bauer emphasises the fact that the results derived from the application of Gaussian analysis (be that correct or incorrect) must be interpreted only in accordance with the properties of the magnetic systems implied in the Gaussian formula. Thus it follows that the vertical component will not be continuous, as the surface enclosing the systems is broken through. — A. D. R.

593. *Iron Cylinder in Homogeneous Magnetic Field.* II. **O. Grotrian.** (Ann. d. Physik, 36. 5. pp. 929–957, Dec. 21, 1911.)—[See Abstract No. 955 (1911).]

594. *Occurrence of Earth Currents.* **A. Nippoldt.** (Meteorolog. Zeitschr. 28. pp. 244–261, June, 1911. Paper read before the Berlin Section of the Deutsch. Meteorolog. Gesell., April 4, 1911.)—A useful summary of past papers on earth currents is given, with typical curves of the daily variation at selected stations. C. P. B.

RADIOLOGY AND ELECTRO-PHYSIOLOGY.

595. *Relation between Energy expended in a Tube producing Röntgen Rays and Ionisation produced by the emitted Rays.* **P. Cardani.** (N. Cimento, 2. Ser. 6. pp. 458–478, Dec., 1911.)—Continuing his research on the conditions for the production of Röntgen rays [Abstract No. 2667 (1904)] the author has determined the effects of varying the capacity of the condenser, the resistance in the circuit, and the explosive distance. For a given resistance the larger the capacity the more energy is utilised, and for the same capacity increase of resistance reduces the energy utilised, the effect of increased resistance being greater for small capacities. The energy available in the tube increases rapidly with the explosive distance, and with the corresponding p.d., due to the increased quantity of electricity taking part in the phenomenon when the explosive distance is extended. The ionisation increases rapidly with the p.d., and is proportional to the energy available, except for very small capacities, or when there is a very large resistance in the circuit, when the ratio of energy to ionisation increases, indicating that in such circumstances the energy spent in internal action in the tube is a larger fraction of the total available energy in the tube. W. H. Si.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

596. *A Chemically-active Modification of Nitrogen produced by the Electric Discharge.* II. **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 86. pp. 56–68, Dec. 22, 1911.)—It has previously been shown [Abstract No. 1839 (1911)] that oxygen destroys the nitrogen afterglow. This destruction of active nitrogen is of a catalytic nature. It further appears that active nitrogen plays no part in the oxidation of nitrogen by the electric spark. Hydrogen, so far as the luminous phenomena are concerned, merely dilutes the active nitrogen without exhibiting its own spectrum. The issuing gases are neutral to litmus paper, there is therefore no formation of ammonia, and in all probability no chemical action at all. Nitric oxide led into active nitrogen combines with it, giving rise to a greenish-yellow flame with continuous spectrum, and forming nitrogen peroxide. If this yellowish-green luminosity is regarded as due to the vibration of some particular atomic or molecular system, it seems likely that this system is the nitrogen peroxide molecule. The reaction with nitric oxide is made use of to estimate the percentage of active nitrogen in the total nitrogen leaving an electric discharge. The method is to add excess of nitric oxide to the glowing nitrogen, and to weigh the resulting blue substance (N_2O_3) which is condensed out from the gases by liquid air. It is shown that 14 parts by weight of active nitrogen yields 76 parts of N_2O_3. The amount (2·5 per cent.) of active nitrogen is thus found to be considerably larger than was formerly supposed. When dilute phosphorus vapour is introduced into the glowing nitrogen it does not react at once; it is not until some time after the glow has completely disappeared that the nitrogen gets into a state in which it can react with phosphorus. The glow has an electrical conductivity which is comparable in magnitude with that of a salted Bunsen flame. The ions are liberated in the glow, not merely carried forward from the original discharge. This ionisation is, as a rule, not very greatly affected when the spectra of other substances, such as metals or cyanogen, are developed by the active nitrogen in the space between the testing electrodes. None of these spectra are visibly diminished in intensity when large e.m.f.'s are applied to remove the ions. Ozone can in some cases develop metallic spectra when mixed at comparatively low temperatures with the metallic vapour. All attempts to isolate the active nitrogen by liquid air condensation have failed. These observations seem very unfavourable to the idea that active nitrogen has a complex atomic grouping, and are, so far as they go, favourable to the idea before suggested that it is monatomic. The simplicity of its spectrum in the visual region as compared with the ordinary nitrogen spectrum may be thought to point in the same direction.

A. E. G.

597. *Action of Ultra-violet Light on Sodium Hyposulphite.* **L. Marmier.** (Comptes Rendus, 154. pp. 32–33, Jan. 2, 1912.)—A Westinghouse lamp, consuming 240 watts, was held 6 or 8 cm. above the solution. When the solution contained less than 6 gm. of hyposulphite per litre, hydrosulphite and some sulphur were produced in 5 min., and after 75 min. nothing but sodium sulphite was left. The rays did not decompose hyposulphite of higher concentration at all. No other figures are given. H. B.

598. *Influence of Radium Rays on Hydrogen Peroxide in Neutral Solution.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1218–1228, July, 1911. Communication from the Inst. f. Radiumforschung.)—The experiments were made on the lines of Fenton [see Abstract No. 8098 (1904)] with the diluted perhydrol of Merck, contained in cylinders of 200 cm.^{3} capacity, and with various quantities of radium-barium chlorides in sealed glass tubes. The walls of the cylinders, and occasionally also the walls of the tubes, were coated with paraffin in some experiments; the tubes contained up to 160 mgm. of $RaCl_2$. The cylinders with the tubes standing in them were placed in the basement (18 to 15° C.), or in a thermostat kept at 25°. The radium radiations increase the rate of decomposition of H_2O_2 both in paraffined and in non-paraffined vessels; the velocity of the reaction is approximately of the first order. The rate increases when more $RaCl_2$ is present, but less rapidly than the concentration of the salt. Especially at the lower temperature (about 14°) the decomposition continued sometimes at the accelerated rate after removal of the radium salt, owing apparently to a modification of the glass walls. The temperature-coefficient of the radiation-effect is small as in most photochemical reactions, 1·2, whilst the spontaneous decomposition of H_2O_2 is very much increased by a rise of temperature. Some H_2O_2 is also produced by the radiations (Kernbaum). H. B.

599. *Decomposition of Nitric Acid by Light.* **W. C. Reynolds** and **W. H. Taylor.** (Chem. Soc., Journ. 101. pp. 181–140, Jan., 1912.)—The authors have confirmed the conclusions of Veley and Manley that light acts only on the vapour of nitric acid and not on the liquid: the extent of the decomposition of the acid in a sealed tube is therefore affected in a very marked way by the ratio of the liquid to the vapour space. The decomposition $4HNO_3 \rightleftharpoons 2H_2O + 2N_2O_4 + O_2$ is reversible: the decomposition-products after exposure to sunlight recombine in the dark, but the pure 100 per cent. acid also undergoes spontaneous decomposition. The course of the action was followed by measuring the pressure of oxygen in the tubes. A pressure of 19 atmos. was reached in a tube containing 100 per cent. acid, exposed during 80 days in Aug. and Sept., 1910, but even in the dark this acid, after remaining colourless for some weeks (a sort of "period of induction"), developed in the course of a year a pressure of 9·7 atmos. T. M. L.

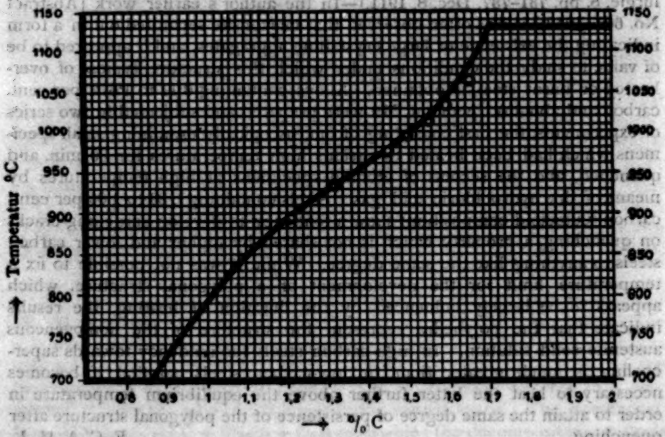
600. *Heat Losses in Resistance Furnaces.* **F. A. J. FitzGerald.** (Amer. Electrochem. Soc., Trans. 20. pp. 281–284; Communication, pp. 284–286, 1911.)—The author modifies his resistance furnaces [see Abstract No. 1257 (1911)] in various ways with the object of reducing the very serious heat losses; the losses are determined by measuring the electric energy required to keep the furnace temperature constant. The result was disappointing. It would appear that—besides making the heat insulation as good as possible—the ratio between hearth area and total area should be large.—**J. Thomson** added some particulars. H. B.

601. *Distillation of Binary Mixtures of Metals.* I. *Isolation of a Compound of Magnesium and Zinc.* **A. J. Berry.** (Roy. Soc., Proc. Ser. A. 86. pp. 67–71, Dec. 22, 1911.)—Commencing with magnesium-zinc, the author has undertaken a series of investigations on the distillation of binary mixtures of metals of which one at least is volatile, in order to determine the general applicability of the method for isolating inter-metallic compounds. Distillation *in vacuo* of a number of mixtures of Zn and Mg in different proportions showed that at comparatively low temperatures a residue of approximately constant composition corresponding to the formula $MgZn_2$ was left behind. Further experiments showed that this compound was stable enough to withstand distillation without decomposition. F. C. A. H. L.

602. *Polyhedral Structure in Iron-Carbon Alloys.* **N. J. Wark.** (Metallurgie, 8. pp. 781–787, Dec. 8, 1911.)—In the author's earlier work [Abstract No. 604 (1912)] it was often observed that martensite separated out in a form indicating the existence of large crystalline aggregates, and it appeared to be of value to study the conditions under which this structure, typical of overheated or burnt steel, is obtained. Alloys containing 0·11 to 1·672 per cent. carbon and about 0·1 per cent. Mn were prepared and subjected to two series of experiments, the first consisting of microscopically examining small specimens which had been heated to various high temperatures for 80 min. and quenched, and the second of etching specimens at high temperatures by means of dry hydrochloric acid gas. Steels containing 0·89 to 1·05 per cent. carbon (eutectoid composition) show a tendency to develop hardening-cracks on quenching, a property which is not shared by higher and lower carbon steels to anything like the same degree. While it was not possible to fix a temperature limit for the development of a polygonal structure, which appears to be largely influenced by the duration of heating, the results indicate that the polyhedra represent the structure of the homogeneous austenite solid solution. In high-carbon steels the tendency towards supercooling is much greater than in low-carbon steels, so that it becomes necessary to heat the latter further above the equilibrium temperature in order to attain the same degree of persistence of the polygonal structure after quenching. F. C. A. H. L.

603. *Rusting of Iron in the Presence of Blast-furnace Slag.* **E. Heyn** and **O. Bauer.** (Königl. Materialprüfungsamt, Mitt. 29. 7 and 8. pp. 454–461, 1911.)—In industrial districts blast-furnace slags are sometimes used as ballast on railways, and in case of the use of iron sleepers they may cause trouble on account of the sulphides in the slag giving rise to sulphuric acid under the action of the moisture and oxygen of the air. This point has been investigated by carrying out comparative rusting tests on sheet steel in the presence and absence of slag. Four samples of slag containing 1·76 to 2·97 per cent. of sulphide sulphur were used in the experiments. In the first series of tests the slags were finely powdered and placed at the bottom of cylinders filled up with distilled water, blank tests being carried out in water and water standing over a layer of sand. One test plate was totally immersed and another half-immersed in the liquid which was stirred up and mixed with the deposit twice a day. In every case the semi-immersed plate rusted at the greater rate. The effect of the slag varies; in some cases it retards, and in others accelerates the rate of rusting. A second series of experiments was carried out in water which had been stirred up with the slag (or sand for the blank), and allowed to settle. The effect was similar; in some cases rusting was retarded, and in others accelerated. In a third series of experiments plates were immersed in pulverised slag moistened with water twice a day, a blank test being carried out in sand. Under these conditions the rusting is greatly accelerated, and the difference between the slags is not strongly marked. F. C. A. H. L.

604. *Determination of the Solubility Curve of Iron Carbide in γ-Iron.* **N. J. Wark.** (Metallurgie, 8. pp. 704–718, Nov. 22, 1911.)—In view of the varying results of previous workers, the author has undertaken a fresh series of experiments with a view to fixing the position of the solubility curve of γ-iron for cementite. Ten samples of steel containing 1·2 to 1·96 per cent. carbon, 0·07 to 0·09 Mn, 0·08 to 0·05 Si, and only traces of other impurities were prepared by melting white Swedish pig-iron with hoof-nail iron in magnesia crucibles. Small specimens of these alloys were heated up to the desired temperature in a salt bath ($BaCl_2$ or KCl + NaCl) and quenched in water. Subsequent microscopic examination indicated the temperature at which cementite commenced to separate. The results confirm Gutowsky's value of 1·7 per cent. for the saturation-point of carbon at 1180° C. [Abstract No. 688 (1910)], and the Fig. shows the observed solubility curve for cementite in γ-iron. In the neighbourhood of this curve, equilibrium between the solid solution and cementite is attained in about 10 minutes. F. C. A. H. L.



605. *Etching of Steel with Simultaneous Colouring.* **F. Robin** and **P. Gartner.** (Rev. de Métallurgie, 8. pp. 224–240, April, 1911. Metallurgie, 8. p. 744, Dec. 8, 1911.)—The polished surface is immersed in a saturated solution of picric acid for 80–60 seconds, washed, and slowly dried in a current of air without handling. The surface is then covered with picric acid, when, during the progress of the etching, the liquid becomes green, then black, at which stage two or three more drops of acid are added and the etching stopped; the surface then shows brown or green reflections according to the intensity of colour required. Washing and drying are carried out as before, when colour-changes are observed, due to the formation of thin layers of unknown character. The rapidity of etching depends upon the nature of the steel, the concentration of the acid, and the temperature. Ferrite is not coloured except in the presence of much phosphorus (1 per cent.); cementite turns brownish after long attack. Austenitic nickel steels colour readily, the colouring increasing with the carbon-content. Martensitic

nickel steels colour with difficulty but the tendency increases with the carbon-content. Austenitic manganese steels etch readily, but the surface is soon covered with a brownish precipitate which causes rapid rusting. This tendency disappears in the high-carbon Hadfield manganese steels.

F. C. A. H. L.

606. *Influence of Annealing on Hardened Friction Bronzes.* **Portevin** and **Nusbaumer.** (Comptes Rendus, 154. pp. 218–215, Jan. 22, 1912.)—The authors have made tests on the wear of bronzes containing 5–20 per cent. tin, with and without 0·011 to 0·020 per cent. phosphorus by pressing samples under a known pressure against the surface of a hard steel disc (Brinell hardness 444) 1 m. in circumference, revolving at the rate of 3200 revs. per min. Occasionally there is a period of 2 to 3 million revolutions during which no wear occurs, after which there is a sudden change and a wear of 0·5 mm. will take place in less than 1 sec. During the no-wear period microscopic examination reveals nothing abnormal, but after annealing for 3 min. at 600° C. the *α* constituent shows distinct twinning in the polyhedra. Polishing removes this appearance, showing that the phenomenon is quite superficial. Comparative examination of a specimen hardened by hammering and a soft specimen, shows that this tendency to twin only occurs in the hammered specimen. This leads to the conclusion that surface hardening of friction bronzes takes place under pressure, and that this hardened pellicle resists wear for a certain period of time.

F. C. A. H. L.

607. *Tempering of Aluminium Bronzes.* **A. Portevin** and **G. Arnou.** (Comptes Rendus, 154. pp. 511–514, Feb. 19, 1912.)—Aluminium bronzes containing 89–90 per cent. Cu consist of a eutectoid in a more or less fine state of division, according to the rate of cooling, and an excess of the Cu-rich *α* constituent. Heating for a sufficient time above the transformation temperature followed by quenching, results in the disappearance of the *α* constituent and the structure becomes wholly martensitic, resembling that of hardened steels. Experiments have been made on the effect of tempering on the structure and properties of two industrial alloys containing 89·84 and 18·80 per cent. Cu, 9·95 and 10·02 per cent. Al, and 0 and 1·11 per cent. of Mn respectively. Brinell and Shore hardness tests made on quenched specimens subsequently tempered for 10 min. at temperatures between 400° C. and 700° C. in a molten salt bath showed that up to 400° C. the hardness was increased. This increase was accompanied by a diminished elongation in a tensile test and an increased fragility under shock. Above 500° C. the hardness diminished to below its original value, the elongation increased and the fragility decreased. Similar phenomena occur in hardened steels and bronzes [Abstract No. 408 (1911)], all of which exhibit martensitic structures. The first effect on the microstructure is to more sharply define the needles and then to thicken them, giving the structure a resemblance to the Widmanstätten figures in meteoric irons. The *α* constituent tends to deposit most rapidly along the edges of the grains and indicates the structure existing at high temperatures. Usually the deposition of a ferrite from martensite does not take place in needles, probably because the grain size is very small compared with that of the bronze. If, however, the conditions are such that the grain size of the steel is on a very large scale, then the deposition of the ferrite produces Widmanstätten figures.

F. C. A. H. L.

608. *Solidification Diagrams of the Ag_2S-FeS and the Mn-As Systems.* **P. Schoen.** (Metallurgie, 8. pp. 737–741, Dec. 8, 1911.)—Thermal analysis of the Ag_2S—FeS system shows that Ag_2S solidifies at 812° C., and FeS at 1171° C., and that the two branches of the liquidus meet in a eutectic point at just over 600° C. and about 11 per cent. FeS. Ag_2S undergoes a transformation at 175° C., but no compounds are formed in the series. Thermal analysis of the Mn-As alloys from 0 to 60 per cent. As, shows the existence of the two compounds Mn_3As and $MnAs_2$ corresponding to maxima at 10·29° and 9·85° C. respectively. F. C. A. H. L.

609. *Conductivity of Pure Ether.* **J. Carvallo.** (Comptes Rendus, 153. pp. 1144–1145, Dec. 4, 1911.)—Schröder has suggested that *pure* ether has a definite electrical conductivity and a dissociation-constant 155×10^{-8} [Abstract No. 1148 (1909)]. By re-distilling in a special form of glass apparatus the author has been able to prepare a material which behaved in the same way, the current diminishing with time but starting with an initial value 50 times smaller. Whereas Schröder's lowest initial current was 9×10^{-10} amp., that now recorded was $0·93 \times 10^{-10}$ only and diminished to a small and very irregular current of the order of 10^{-11} amp. at 425 volts. These minute currents were measured by using them to charge a quadrant electrometer. T. M. L.

610. *Conductivity of Salts in Methyl and Ethyl Alcohols at High Dilutions.* **H. R. Kreider and H. C. Jones.** (Amer. Chem. Journ. 46. pp. 574–585, Dec., 1911.)—Steady values for the equivalent conductivities of binary salts dissolved in methyl and ethyl alcohols were actually observed at a dilution of about 10,000 litres. Beyond this point a decrease was often observed, but in some cases erratic high values were recorded at extreme dilutions. In the case of salts which are combined with the solvent to approximately the same extent, the ratio of μ_∞ in two solvents is practically constant, *e.g.*, for KI, NaI, $LiNO_3$, NaBr, NH_4Br, KCNS, the ratios are—

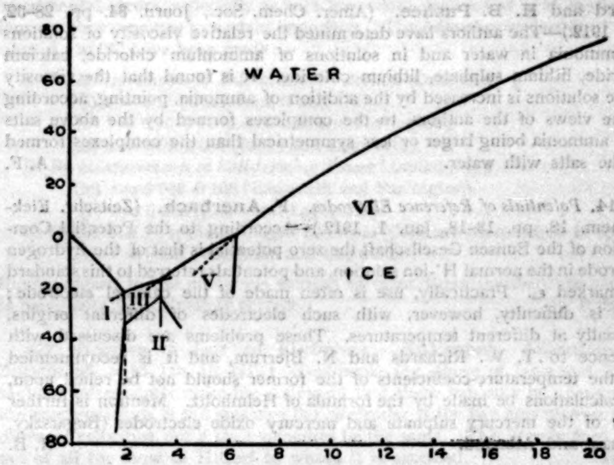
Water : methyl : ethyl alcohol.
At 0° = 2·33 : 2·44 : 1

But for cobalt chloride, a ternary salt which is much more strongly hydrated the ratios are—

At 0° = 3·70 : 3·67 : 1 T. M. L.

611. *Change of Volume on Dilution of Non-Colloidal Solutions with Water.* **F. Bottazzi and G. Buglia.** (Accad. Lincei, Atti, 20. pp. 627–633, Dec. 3, 1911.)—Employing their new form of dilatometer [Abstract No. 502 (1912)], the authors have measured the change in volume on diluting with water normal solutions of H_2SO_4 and HCl, 1·97-N NaOH, and solutions of NaCl containing 30 and 5·5 per cent., of sp. gr. 1·14909 at 4° C. In each case there was a distinct contraction in volume, that found for the last-named solution agreeing well with the result calculated from the tables of Landolt-Bjornstein. W. H. Si.

612. *Water, in the Liquid and Five Solid Forms under Pressure.* **P. W. Bridgman.** (Amer. Acad., Proc. 47. No. 13. pp. 441–558, Jan., 1912.)—The author has extended Tammann's experiments, which reached to a pressure of 3500 atmos., by carrying the measurements of volume up to 20,000 atmos. The most striking result of the experiments is the discovery of two additional forms of dense ice, which are named Ice V and Ice VI. Ice V melts at −17° under 3530 kg./cm.² and at +0·16° under 6380 kg./cm.². Ice VI melts at +0·16° under 6380 kg./cm.², and shows a progressive rise of freezing-point up to 76·35° C. at 20,670 kg./cm.². This form of ice is therefore stable over a range of pressures at least twice as great as that of the preceding five varieties, and the author considers that there are indications that it is the final form of ice. He adopts the view that the equilibrium curve for Ice VI and water would run on progressively without reaching a maximum or a critical temperature at which the properties of liquid and solid would be identical. The author was not able to confirm Tammann's observation that a second metastable form of light ice may be formed by freezing at low pressures, but has, by naming his two new varieties Ice V and Ice VI, reserved the name "Ice IV" for this possible additional form. He has also plotted a definite equilibrium-curve for Ice III and Ice II; the latter is stable at temperatures below −38·4° at 2290 kg./cm.² and below −26·0° at 3220 kg./cm.². It is thus a modification of ice, the production of which from Ice III is determined much more by temperature than by pressure. The small influence of pressure is caused by the very small difference of volume of the two forms; this difference is so small that it was overlooked by Tammann, who regarded Ice II as a metastable variety of Ice III, just as Ice IV was a metastable variety of Ice I. The complete equilibrium-diagram for water and the five varieties of ice is reproduced herewith. The chief effect of pressure on liquid water, which was investigated up to about 10,000 atmos. is to smooth out the abnormalities which occur at low pressures, and which have been attributed by Röntgen and others to reversible polymeric change. At 1500 atmos. the max. density disappears. At this pressure the volume remains almost constant from 9401 at −15° to 9401 at 0° C., but a curve for volume against temperature plotted on a large scale shows a shallow minimum at −5° and



maximum at −10°; this result is in accord with the author's theoretical views, according to which there are two possible volume-temperature curves, one for dense water and one for the lighter polymeride. The minimum compressibility disappears at 8000 atmos. It is remarkable that this minimum is not much displaced by pressure; the author concludes from this that the difference in density between the two varieties of water diminishes as the pressure increases, but that the proportions are not materially altered; it may, however, be explained also by the occurrence of light varieties at both high and at low temperatures. The compressibility measurements indicate that at high pressures some new factor develops, perhaps the compressibility of the molecules or atoms themselves, as distinguished from the space separating them. T. M. L.

613. *Viscosity of Solutions of the Metal Ammonia Salts.* **A. A. Blanchard** and **H. B. Pushee.** (Amer. Chem. Soc., Journ. 34. pp. 28–32, Jan., 1912.)—The authors have determined the relative viscosity of solutions of ammonia in water and in solutions of ammonium chloride, calcium chloride, lithium sulphate, lithium chloride. It is found that the viscosity of the solutions is increased by the addition of ammonia, pointing, according to the views of the authors, to the complexes formed by the above salts with ammonia being larger or less symmetrical than the complexes formed by the salts with water. A. F.

614. *Potentials of Reference Electrodes.* **F. Auerbach.** (Zeitschr. Elektrochem. 18. pp. 13–18, Jan. 1, 1912.)—According to the Potential Commission of the Bunsen Gesellschaft the zero potential is that of the hydrogen electrode in the normal H$^{\cdot}$-ion solution, and potentials referred to this standard are marked ε_h. Practically, use is often made of the calomel electrode; there is difficulty, however, with such electrodes of different origins, especially at different temperatures. These problems are discussed with reference to T. W. Richards and N. Bjerrum, and it is recommended that the temperature-coefficients of the former should not be relied upon, but calculations be made by the formula of Helmholtz. Mention is further made of the mercury sulphate and mercury oxide electrodes (Bugarszky, Donnan and Allmand. H. B.

615. *Contact E.M.F. between Metal and Electrolyte.* **J. Guyot.** (Comptes Rendus, 153. pp. 867–869, Nov. 6, 1911.)—If air is ionised between two different metallic plates forming the coatings of a condenser they acquire a p.d. equal to their apparent contact p.d. The author uses this method to determine the p.d. between a metal and an electrolyte. The former was constituted by a piece of gilt wire gauze, suspended over an electrolyte connected to an electrometer by means of a reversible electrode containing either the same anion or the same kathion as the solution in question. The ionisation of the air was produced by polonium. In about half an hour a steady p.d. was indicated between metal and electrolyte. It was found to be proportional to the logarithm of the concentration of the electrolyte. With a calomel electrode the coefficient was 0·0525 for HCl, 0·058 for KCl, and 0·054 for AmCl. With a silver electrode, AgNO$_3$ gave 0·0525 and with a Cu electrode CuSO$_4$ gave 0·0250, and Cu(NO$_3$)$_2$ 0·0187. The general law governing the p.d. is $V = V_0 \pm (1/p)(0{\cdot}058 \log c)$, where c is the concentration and p the valency. The author concludes that Helmholtz's concentration formula for cells also applies to the cells here investigated. E. E. F.

616. *E.M.F.'s in Alcohol. II. Influence of Water on the Hydrogen Electrode.* **R. T. Hardman and A. Lapworth.** (Chem. Soc., Journ. 99. pp. 2242–2258, Dec., 1911.)—The solvate theory of acids indicates that, in highly dilute moist alcoholic solution the concentration of the free hydrogen ions from a mineral acid may be represented by the expression $[H] = [H_0]r/(r + w)$, where $[H_0]$ is the concentration of "free" hydrogen ions in the anhydrous solution, w is the concentration of water in gm.-mols. per litre, and r is the "water-value" of the alcohol at the temperature referred to. If the conception of "free" hydrogen ions is discarded, the law may be expressed in terms of the availability, P, of the acid, thus $P = P_0r/(r + w)$, where P_0 is the availability of the acid in anhydrous solution. Experiments on three independent lines confirm the general applicability of the above formula. The only discrepancy concerns the precise value of r at 25°; this discrepancy is probably due to the small magnitude of r, and the difficulty of eliminating experimental errors, especially as with low concentrations of acid the solutions are very sensitive to certain impurities. The following estimates of the value of r at 25° have been made:—

A. *By Measurements of Esterification Velocities* (Catalysis).
  (i) $r = 0{\cdot}15$ (Goldschmidt and Udby).
  (ii) $r = 0{\cdot}10$–$0{\cdot}11$ (Lapworth and Partington).
  (iii) $r = 0{\cdot}09$–$0{\cdot}095$ (Jones and Lapworth).
B. *By Measurements of Salt-forming Power* (Availability).
  (iv) $r = 0{\cdot}089$–$0{\cdot}108$ (Lapworth and Partington).
  (v) $r = 0{\cdot}095$ (Jones and Lapworth).
C. *By the E.M.F. of the Hydrogen Electrode* (Concentration of free $H^{\cdot}$ ions).
  (vi) $r = 0{\cdot}127$ (Hardman and Lapworth).

Having regard to the numerous sources of error, these numbers are quoted as being only approximately correct. T. M. L.

617. *Migration of Ions on Electrolysis.* **Kalischer.** (Elektrotechn. Zeitschr. 33. p. 55, Jan. 18, 1912.)—Text-books (*e.g.*, those of Jahn and Ramsay) not infrequently make the statement that there can only be changes in the concentrations of the ions near the electrodes, if the two ions migrate with different velocities, not if their velocities be the same. This is erroneous, and not at all the view of Hittorf to whom it is ascribed. H. B.

618. *Capacity of Electrolytic Valve Action in Fused Salts and in Absolute Sulphuric Acid.* **G. Schulze.** (Zeitschr. Elektrochem. 18. pp. 22–29, Jan. 1, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—The author continues his researches [see Abstract No. 1289 (1911)] in order to ascertain whether the non-dependence of the thickness of the inner film upon the electrolyte is maintained when we pass from aqueous solutions to fused salts. The dielectric constant is, as before, assumed equal to unity, the method for measuring the capacity (Maxwell) is modified, and these measurements are referred to a formation-period of 30 minutes at 50 volts. In the case of tantalum the thickness increases as the water percentage in the solution or fused salt decreases. The same holds for Ta and Al in sulphuric acid, as the concentration of the acid increases. In the various fused salts (nitrates of Tl, Na, K, Li, (K + Li), n-H_4SO_4, $KHSO_4$, $K_2Cr_2O_7$) the thickness is the greater and the capacity the lower, the higher the melting-point of the salt or salt mixture, and it would appear that there could be no valve effect above 510° C. H. B.

619. *Aluminium Anode-films.* **G. E. Bairsto** and **R. Mercer.** (Faraday Soc., Trans. 7. pp. 1–28; Discussion and Communications, pp. 28–29, Nov., 1911. Elect. Rev. 68. pp. 628–629, April 21, 1911.)—Examining previous researches, the authors support the view that the anode-film consists of two layers: an outer, thick, conducting film, whose thickness varies with the electrolyte; and an inner, thin dielectric film (oxygen in some condition) whose thickness is independent of the electrolyte, for which they assume the constant $k = 1$; **W. C. McLewis** questioned this assumption. The electrolytes studied comprise the prussiates, ammonium arsenite, arsenate, and molybdate; the latter is recommended because the capacity is little influenced by temperature in this case, whilst the capacity in ammonium borate increases with temperature (which effect afterwards persists after cooling), and decreases with rising temperature in sodium phosphate. There is always a slow decrease of the capacity with time; this is very slow when the formation voltage has been high. Oscillograph studies show that the asymmetry of the conductivity does not become pronounced before the pressure has risen above 20 volts. H. B.

620. *Chemical Attraction between Atoms.* **R. D. Kleeman.** (Phil. Mag. 21. pp. 83–102, Jan., 1911.)—An investigation of the determination of the law of chemical attraction between atoms from physical data.

621. *A Structural Theory of the Chemical Elements.* **J. W. Nicholson.** (Phil. Mag. 22. pp. 864–889, Dec., 1911.)—A somewhat speculative paper which does not lend itself to abbreviation. The original should be referred to. The subject is treated under the headings: Primary substances, or "Protyles"; Nature of compounds; Atomic weight; Compound atoms; The inert gases; Other groups of elements. L. H. W.

622. *Weight of a Normal Litre of Hydrogen Chloride and the Atomic Weight of Chlorine.* **F. P. Burt** and **R. W. Whytlaw-Gray.** (Faraday Soc., Trans. 7. pp. 30–40; Discussion, pp. 40–41, Nov., 1911. Chem. News, 103. pp. 161–164, April 7, and pp. 170–171, April 14, 1911.)

623. *Effect of Penetrating Rays on Alkali Iodides in Water.* **A. Kailan.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1373–1400, Oct., 1911.)

624. *Proposed System of Notation for Physico-chemical Quantities.* **A. A. Noyes.** (Amer. Chem. Soc., Journ. 34. pp. 1–6, Jan., 1912.)—After laying down certain principles which should form the basis of the system of notation, the author gives the symbols to be used for: geometrical and mechanical quantities; energetic, thermal and chemical quantities; electrical quantities; and optical and special quantities. T. S. P.

625. *The Allotropy of Metals.* **E. Cohen.** (Faraday Soc., Trans. 7. pp. 122–133; Discussion, pp. 133–135, Nov., 1911.)—Deals with the allotropy of tin and with explosive antimony.

626. *A Study of Mercury-Sodium Alloys.* **E. Vanstone.** (Faraday Soc., Trans. 7. pp. 42–63; Discussion, p. 63, Nov., 1911. Chem. News, 103. pp. 181–185, April 21, and pp. 193–201, April 28, 1911.)

627. *Pellets and Segregation in Iron Castings.* **E. L. Rhead.** (Mech. Eng. 29. pp. 200–201, Feb. 16, 1912. Paper read before the Manchester Section of the British Foundrymen's Assoc., Feb. 8, 1912.)